

## DOCUMENT RESUME

ED 281 348

EC 192 445

AUTHOR Tallal, Paula  
TITLE Interagency Committee on Learning Disabilities:  
Report to the U.S. Congress: Developmental Language  
Disorders.  
SPONS AGENCY National Inst. of Neurological Diseases and Stroke  
(NIH), Bethesda, Md.  
PUB DATE Dec 86  
GRANT IP50NS22343-01  
NOTE 95p.  
PUB TYPE Information Analyses (070)

EDRS PRICE MF01/PC04 Plus Postage.  
DESCRIPTORS \*Clinical Diagnosis; Definitions; Elementary  
Secondary Education; Etiology; Handicap  
Identification; Incidence; \*Intervention; \*Language  
Handicaps; \*Learning Disabilities; Prevention;  
\*Research Needs; \*Student Characteristics  
IDENTIFIERS Interagency Committee on Learning Disabilities

## ABSTRACT

The report to Congress comprises a description of the current research findings on the definition, associated characteristics, diagnosis, prognosis, prevalence, causes, and treatment of developmental language disorders. Each section both reviews current literature and notes research as well as clinical needs, as related to issues of prevention. Individual author-contributed sections are on the following topics: (1) linguistic characteristics and subtypes of language-impaired children, deviance or delay, language testing, and cognitive development (S. Curtiss); (2) language intervention research (L. Olswang, C. Mateer, and B. Bain); (3) interventions for auditory perceptual and phonological disorders (C. Sloan). Among conclusions are that intervention research has tended to address one of three broad categories of inquiry--effectiveness of procedures, effects of procedures, and language acquisition process; and that research is needed in such areas as normal and disordered development of auditory and language functions and long term followup of language impaired children. Assumptions pertaining to treatment are identified and include the value of early rather than later intervention and the stimulating effect of language intervention on overall language development. The lack of adequate longitudinal studies to determine the long-term prognosis of children with language impairments is noted. A bibliography of approximately 360 items is included. (DB)

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ED281348

INTERAGENCY COMMITTEE ON LEARNING DISABILITIES  
REPORT TO THE U.S. CONGRESS: DEVELOPMENTAL LANGUAGE DISORDERS

Paula Tallal, Ph.D.

December 1986

Grant No. 1P50NS22343-01  
National Institute of Neurological Diseases & Stroke  
Bethesda, Md.

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INTERAGENCY COMMITTEE ON LEARNING DISABILITIES  
REPORT TO THE U.S. CONGRESS: DEVELOPMENTAL LANGUAGE DISORDERS

Paula Tallal, Ph.D.

This report comprises a description of the current research findings on the definition, associated characteristics, diagnosis, prognosis, prevalence, causes and treatment of developmental language disorders. Each section both reviews current literature and focuses on future research as well as clinical needs, as they relate ultimately to issues of prevention. This section of the Congressional Report on Developmental Language Disorders incorporates the views and reviews of several of my colleagues who contributed to this report. The section on linguistic characteristics and subtypes of language impaired children, deviance or delay, language testing, and cognitive development were contributed by Dr. Susan Curtiss, a developmental psycholinguist at UCLA. The section reviewing language intervention research was co-authored by three research speech pathologists: Dr. Lesley Olswang and Dr. Catherine Mateer from the University of Washington and Dr. Barbara Bain from the University of Montana. Another speech pathologist, Dr. Christine Sloan from Halifax, contributed the section on interventions for auditory perceptual and phonological disorders. Several of my students from the Neuroscience, Psychology, and Linguistics programs at UCSD reviewed relevant portions of the literature which are incorporated into this report. These include: Sharon Hendricks, Dianne Dukette, Randy Ross, and Tony Mauro. The work of my own laboratory, reviewed in this report, has been funded by the NINCDS, NIMH, and the MacArthur Foundation.

## I. Definition

### A. Exclusionary Criteria

Language is one of the most complex of all human functions. Normal language development requires the integration of sensory, attention, perceptual, cognitive, motor, and linguistic functions. When one or more of these functions fails to develop normally, language development may be delayed or disordered as a result. Consequently, global mental retardation, hearing impairment, autism, paralysis, or malformation of the vocal apparatus (as in cleft palate), emotional disturbance, frank neurological dysfunction (such as seizure disorder or brain lesions) are conditions which commonly predispose a child to fail to develop normal language at or near the expected age. Language disorders which arise in the presence of one or more of these predisposing peripheral or central impairments are considered to be resulting symptoms of the more pervasive disorder, rather than the primary disorder itself. For example, children with significant hearing loss often have resulting language deficiencies. However, they are not considered to be primarily language impaired. Similarly, language dysfunction can also result from acquired postnatal brain injuries to the areas of the brain which subserve language in the adult. Such language dysfunction is referred to as "acquired aphasia." Although children with language disorders that are secondary to other primary disorders may share many associated characteristics with those of children with primary or specific developmental language disorders, they will not be the focus of this report.

There are children with seriously compromised language development that cannot be attributed to any of the above mentioned common causes of language disorders. These children appear to be developing normally in all areas except for language. Early descriptions of these specifically language impaired (LI) children focused on their observed similarity to adult aphasics. They were defined in terms of presumed underlying brain dysfunction or etiology, as opposed to linguistic dysfunction (Myklebust, 1954; McGinnis, 1963; de Ajuriaguerra et al, 1976).

Benton (1964) was the first to suggest that there is a distinct clinical syndrome, which he termed developmental aphasia,<sup>1</sup> that is characterized by a child who shows a relatively specific failure of normal language functions in the absence of those factors which often provide the general setting in which failure of language usually is observed: deafness, mental deficiency, motor disability, or severe personality disorder. The failure can manifest itself either as a disability in expressive language only, with near normal receptive language, or as a disability in both receptive and expressive language. Benton further noted that the interrelationship between language disability and articulation disorder is inconsistent. That is, some developmentally aphasic children also demonstrate impaired development of speech articulation, whereas others do not.

Though developed almost two decades later, the American Psychiatric Association nomenclature (DSM-III, 1981) unfortunately adds very little additional information to the definition of developmental language disorders originally proposed by Benton (1964). Like Benton, the DSM-III divides developmental language disorders into two basic types: The expressive type is characterized by a failure to develop vocal expression of language despite relatively intact comprehension of language; the receptive type is characterized by a failure to develop both comprehension and vocal expression of language. Developmental articulation disorder is listed as a separate diagnostic category, distinct from developmental language disorders. An articulation disorder is characterized by a failure to develop consistent articulations of the sounds of speech. Although listed as a distinct diagnostic category in DSM-III, research has demonstrated that the interrelationship between phonological development (the development of the perception and production of speech sounds) and language development is complex. It is now widely accepted that there are many LI children who have concomitant speech articulation disorders and there are also LI children who exhibit normal articulation. Conversely, there are children with disordered articulation in the absence of developmental language delay (Aram and Kamhi, 1982; Wolfus et al, 1980).

Even a cursory look at these definitions of specific developmental language disorders demonstrates clearly that these are definitions by exclusion. That is, children are defined as developmentally language impaired based on clinical tests that demonstrate those aspects of their development which are not responsible for their language problems. The definition, by default, implies

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<sup>1</sup>The terms developmental aphasia or dysphasia, specific developmental language delay, deficit, disorder, or impairment will be used interchangeably in this report.



that the disorder is specific to language, and is developmental or congenital rather than acquired.

## B. Associated Characteristics (Inclusionary Criteria)

Although clinical definitions have tended to focus on exclusionary criteria, primarily for the purpose of deferential diagnosis, research has focused on developing inclusionary criteria based on investigations which demonstrate profiles that are characteristic or associated with developmental language delay. Research in the field has focused on two main approaches: 1) investigating in more detail the receptive and expressive linguistic development of language impaired children (the psycholinguistic approach); and 2) investigating in these children perceptual, motor, and cognitive mechanisms that are presumed to be prerequisites for normal language development (the neuro-psychological approach).

### 1. Linguistic Characteristics

Determining the patterns of language acquisition in LI children has been a major focus of research. The central questions to be answered are: 1) What is the nature of language acquisition in the LI child; and 2) Is language acquisition in the LI child merely delayed, or is it deviant as well as delayed? To answer these questions, the grammars of LI children must be characterized with respect to the linguistic representations and grammatical principles embodied in each linguistic component (phonology, morphology, syntax, and semantics) and at different levels of grammar (e.g., D-structure, S-structure, logical form, phonetic form). In addition, to determine patterns of grammar acquisition in the LI child, analyses of the internal changes in their grammar at consecutive stages must be carried out. Only through such analyses can the nature of language acquisition be ascertained. Such analyses require knowledge of linguistic theory, however; and for the most part, linguistic theory has not informed the description of language disorders in children. Rather, what has largely been documented are many linguistic phenomena associated with the language development of LI children. Descriptions converge to build a picture whereby certain phenomena are characteristically associated with language-learning in the LI child, and it is these that will be detailed below.

#### a. Phonology

In phonology, there are two main questions to be addressed: 1) whether LI children are using normal phonological principles in their acquisition; and 2) whether LI children are acquiring the language-particular facts of the target language (in this case, English). Most phonological studies of LI children have been concerned with the second question, and most of these deal with English-specific rules of allophony, phonemic distinctions, and syllable structure.

Numerous studies have examined the phonetic realization of segments and syllables in the speech of LI children (Compton, 1970; Ingram, 1976; Oller, 1973; Campbell and Shriber, 1982; Shriberg et al, 1986). The consistent conclusion was that LI children demonstrate, on the whole, nearly identical phonological processes as those found in the grammars of younger, normal children (syllable

and segment simplification and assimilation as reflected by cluster reduction, final consonant deletion, substitution of one stop for another or of stops for spirants, etc.). However, these studies are in general actually concerned with the phonetic specification of segments or segment combinations, and as a result indicate that the phonetic processes extant in the speech of LI children are normal. Unfortunately, they say little about their phonology, that is, for example, whether or not LI children are acquiring and making use of the actual phonological rules of adult English. Nonetheless, these studies suggest (albeit indirectly) that in many instances, underlying phonological representations of individual lexical items are normal.

A few studies stand out as exceptions in that they address the first question raised above (Camarata and Gandour, 1984; Leonard, 1985; and to a lesser extent, Leonard and Leonard, 1985). In the Camarata and Gandour study, the authors are able to show how, by utilizing a rather straightforward phonological analysis (in this case, that of examining the distributional facts for the occurrence of certain phonetic segments) what looks like an aberrant and unprincipled system on the surface can be revealed to be the output of a normal phonological rule, one that just doesn't happen to hold for English. In this case, the important distinction between the acquisition of language-particular facts versus what is a possible phonological rule is made. In the Leonard and Leonard study, the importance of looking at even word-level phonetic context in capturing the rules a child may be using is demonstrated. Although the authors do not appear to appreciate the larger theoretical context into which their findings could be placed (i.e., as evidence in support of the theory of CV or skeletal phonology and evidence to indicate that LI children, like normal children, appear to know and make use of phonological tiers in their language acquisition) once again they are able to make generalizations about data which, without consideration of contextual phonetic information, could not have been observed. In addition, as with the Camarata and Gandour study, Leonard and Leonard are able to suggest a rule in the child's system which can be motivated phonetically (as is the case with almost all known phonological rules) suggesting that normal underlying phonological principles are at play, even when the language-particular facts have not been mastered. Leonard (1985) proposes a specific mechanism to account for how both LI and young, normal children arrive at distorted productions of target words. Although he does not offer an explanation for phonological disorders, themselves, he argues convincingly for strong similarities between LI and much younger normal children in both their surface and underlying lexical phonologies.

While the above data suggest a delay in the phonological acquisition of LI children, an additional and important finding emerging from studies of their phonological development is that early acquired forms persist, or coexist in free variation with later acquired forms, over protracted periods of time (e.g., Lorentz, 1972; Edwards and Bernhardt, 1973; Salus and Salus, 1973; and to a lesser extent, Ingram, 1976). As the acquisition of new phonological forms presumably reflects changes in the grammar that should rule out the old forms, the coexistence of distinct and competing phonological representations is a phenomenon which potentially marks the phonological development of LI children as deviant. It suggests that LI children may be constructing grammars which tolerate a variance in representations which would be disallowed in the

normal course of acquisition. Such grammars might then be the result of normal acquisition processes. Free variation of competing forms might, however, reflect specific production difficulties rather than differences in grammar per se, and only the analysis of a variety of phonological phenomena over successive stages in phonological development can help to decide between these possibilities. The situation remains an unexplored but potentially critical area to investigate further in addressing the delay versus deviance issue.

#### b. Morphology

There are perhaps three primary questions to be addressed in this area: 1) Do LI children know the principles underlying word formation and acquire normal word-formation rules; 2) Do LI children acquire the word-formation rules of English normally; and 3) Does inflectional and other nonlexical morphology bear the same relationship to syntax and phonology in the grammars of LI children as it does in the grammars of normally developing children.

There are few, if any, studies that address the first two questions directly. Most studies in this area have examined the acquisition of specific morphemes and not knowledge of word formation per se. It is striking, however, that no study reports the creation of impossible (in the sense of not allowed by human grammars) word forms by LI children. Moreover, no study reports the use of noun morphology with verbs or vice versa. While English is a less than ideal target language in this regard, given its paucity of bound morphology and the phonetic isomorphism of many of the relevant forms which exist, the data on acquisition of nonlexical morphology in LI children suggest that their grammars embody both normal general principles and correct language-particular rules for word formation. Their use of inflectional morphology also shows consistent and accurate syntactic classification of both roots and inflectional morphemes.

Some work has been done examining the interaction of morphology with phonology in LI children (Smit and Bernthal, 1983; and Camarata and Gandour, 1985). Predictably, there is a clear interplay between the phonetic abilities of LI children and the realization of many morphological inflections. However, there are no data to suggest that morphology and phonology interact in an abnormal way in this population.

Most studies pertaining to acquisition of morphology in LI children have concentrated on the acquisition of specific morphemes, the order in which they are acquired, and the relationship between occurrence of particular morphemes in the speech of LI children and "grammatical stage" as defined by measures of utterance length. Ingram, (1972) Kessler, (1975) Johnston and Schery, (1976) and Steckol, (1976) for example, studied the acquisition of a predefined set of inflectional and freestanding grammatical morphemes on which there are considerable normal acquisition data. They examined the order in which these morphemes were acquired and the stage (determined by MLU or mean number of words per sentence) at which they appeared. In each of these studies, LI children appeared to acquire these morphemes in approximately the same order as normal children, but neither their earliest occurrence nor the point of mastery co-occurred with the same developmental stage as was the case for normal children. Typically, LI children produced specific morphemes at earlier stages

than normal children, but did not control them until later stages. A somewhat more enlightened study (Johnston and Kamhi, 1984) reveals that LI children differ from normals in that the LI children tend to produce constructions requiring the use of more grammatical morphology, but then omit more of these forms in obligatory environments.

These studies, then, suggest that with respect to order of acquisition of non-lexical forms, LI children evidence normal acquisition patterns, but that with respect to the relationship between morphological acquisition and syntactic "stage," LI children may exhibit deviance. Here, as before, informed linguistic analyses are called for, however. Length of an utterance tells us little about its internal syntactic structure. Although MLU or MMU have been widely used as indices of grammatical development, acquisition in languages that have considerably richer morphological systems than English demonstrate the inadequacy of such measures rather clearly (e.g., Hyams, 1983; Berman, 1981). Children learning a language with an elaborate morphology such as Hebrew, German, or Italian, for example, use inflectional morphemes even in single-word utterances, that is, utterances with the simplest syntactic structures possible. Johnston and Kamhi also point out the inadequacy of MLU as a measure even when considering only rather syntactical factors. What is needed, then, are studies of the relationship between the acquisition of actual syntactic structures and acquisition of morphology, on the order of those carried out on normal acquisition (e.g., Hyams, 1983, 1986; Klein, 1985). Such analyses will determine whether particular changes in morphology (e.g., acquisition of the finite/infinite clause distinction) are linked to acquisition of tense morphology. Only then will we have direct evidence as to whether the acquisition of morphology in LI children is normal or not.

### c. Syntax

The central questions to be addressed here are: 1) Do LI children appear to construct grammars embodying universal syntactic principles; 2) Do LI children show normal acquisition patterns in the instantiation of these principles for English; and 3) Do LI children show normal patterns for acquiring English-specific syntactic phenomena.

Studies in this area rarely address these questions. For the most part, they consist of taxonomic-type investigations of the syntactic forms used by LI children. Menyuk (1964) and Leonard (1972) found that LI children used "normal" NP, AUX, and VP structures, as well as structures involving embedded clauses (complements and relatives). Morehead and Ingram (1973) found that LI children on the whole used particular syntactic categories and structures less frequently than normal age-matched peers, but with the same frequency as normals matched for MLU. Johnston and Kamhi (1984) found LI children typically to have acquisition difficulties with grammatical markers in general.

Very few studies in this area have been guided by syntactic theory. Early exceptions undertook to perform early-version transformational grammar analyses on the speech of LI children, finding on the whole that LI children produced sentences that involved fewer distinct phrase structure and transformational rules than did normal peers (Morehead and Ingram, 1973; Menyuk, 1964; Lee, 1966). Researchers in this area have failed to utilize more current syntactic



theory, however, and syntax perhaps more than any other component of the grammar has been underinvestigated.

Two findings that have emerged nonetheless are worth noting. Both of them are reported in Lee (1966). In this article, among other things, she considers the fact that LI children frequently produce ungrammatical utterances. First, Lee observes that in many cases, LI children produce ill-formed sentences that result from using semantically appropriate lexical items whose syntactic requirements lie outside their syntactic competence. For example, children may use verbs like "guess" or "think," which require a sentential complement (in most cases) before their grammars can generate sentential complements. This may be a phenomenon that occurs in normal acquisition, as well, but the extent to which such potentially problematic asynchronies exist in the grammars of LI children may be abnormal and may provide an important clue regarding the character of grammar building in this population. A second noteworthy observation made by Lee is that LI children produce ungrammatical utterances consisting of word strings that appear to lack any internal syntactic structure. This raises the disturbing possibility that in at least some instances, long past the earliest stages of "beginning to talk," LI children may be constructing utterances outside the framework of a grammar. Since the examples Lee presents do not appear to be social formulas or other typically automatic or "extragrammatical" utterances, this phenomenon could be a marker of clearly deviant language development.

As the distinction between children with preschool language impairments and those evidencing school-age developmental dyslexia may be at least partially artificial, one study of adult developmental dyslexics deserves mention here. Kean (1984) conducted a linguistic investigation into the syntactic abilities (judgement, interpretation, and processing) of adults who were dyslexic as children. She found that the adult dyslexics failed to make correct grammaticality judgements for sentences involving construal of pronouns and anaphors and, in addition, incorrectly interpreted sentences involving certain kinds of referential dependencies. In both cases, the sentences causing problems for the dyslexics involved the Binding principles, syntactic constraints governing the interpretation and dependency relations of the different classes of noun phrases: R-expressions (regular nouns), pronouns, and anaphors (reflexives and reciprocals). What Kean found, therefore, was an anomaly or deficit in a specific aspect of syntactic knowledge. Although only a pilot study, her findings raise very specific questions concerning the syntactic abilities of this and other disordered populations. What is especially important about this work with dyslexic adults is that the generalizations concerning their performance could be made only through Binding Theory, part of current syntactic theory. Other generalizations concerning patterns in the performance of LI children will also be observable and characterizable only through a theory about the knowledge base in question.

Clearly, much more research on the syntax of LI children is called for. The essential questions in this area remain completely unanswered. For the most part, syntax in LI children has been taxonomized, not characterized. This is an unfortunate state of affairs, as an examination of the syntax of LI children may shed the clearest light on whether or not they have specifically linguistic deficits. However, there is no question that productive research in



this area, work which can uncover important generalizations about the syntax of this population, will have to be informed and guided by linguistic theory. Only then can basic questions concerning the LI child's acquisition of even the most fundamental properties of human syntax be addressed. Some of these questions are currently being studied as part of the NINCDS-funded San Diego Longitudinal Study of the Outcomes of Early Language Disorders (Tallal and Curtiss, 1980-1988).

#### d. Semantics

The major questions to be addressed in the area of semantics are: 1) Do LI children acquire a normal lexicon, wherein words are learned, represented, and used in a normal manner; and 2) Do LI children learn to map propositional meanings onto linguistic structures in a normal fashion.

Work on semantics in general suffers from the absence of a coherent theory of semantics or semantics acquisition. Therefore, the work on semantics in children with language disorders has proceeded in much the same fashion as equivalent work on normal language acquisition. Both of the above questions have been addressed, with a concentration on the acquisition of meaning relations between words and, more recently, acquisition of individual lexical items themselves.

Research into the acquisition of meaning relations in LI children has found that these children express the same range of thematic roles as do normal children. Freedman and Carpenter (1976) for example, found no differences between normal and LI children in the semantic roles they encoded in their utterances at the earliest stages of speech. Leonard et al (1976, 1978) also found no differences in the range of semantic roles expressed between LI children and age-matched normal peers, but did find differences in the frequencies with which specific roles were expressed when age-matched peers were used, with LI children tending to use earliest acquired semantic relations more frequently. These differences disappeared when language-matched peers were used for comparison.

It is difficult to know what to make of these findings. These studies examined only a relatively small set of possible semantic categories which may have left areas of difference unexplored. Moreover, the set considered may represent semantic primitives or primes, an unlearned, basic set of meaning relations. Evidence from Brown (1973), Bowerman (1973), Greenfield and Smith (1976) and many others studying the earliest stages of language production suggests that this may be the case, as even the youngest and least linguistically developed children in these studies express all of the semantic roles used in the above-mentioned studies on LI children. However, using a more extended set of semantic categories, including those of irrealis, intentionality, causative, obligation, and temporality, Curtiss and Tallal (1985) again found no differences between LI and language-matched normals on the range of categories expressed. Differences between groups also failed to show up when considering degree of unsemantic or semantically ill-formed propositions.

The expression of multipropositionality has, however, been shown to differen-

tiate between at least some LI and language-matched children. Johnston and Kamhi (1984) found that LI children expressed fewer logical propositions per utterance, even while producing utterances which were comparable in length to those of MLU-matched normals. This resulted from the increased use by LI children of simple progressive aspect and greater use of motion verbs whose obligatory arguments can be expressed within a single proposition. In the Curtiss and Tallal study, in contrast, there was a significant difference only between a particular subgroup of LI children and both the other LI children and the age-matched normals, on the extent to which they could express multipropositionality.

Recent studies have also examined the nature of lexical acquisition (e.g., Leonard et al, 1982; Chapman et al, 1983; Schwartz and Leonard, 1985; Camarata and Schwartz, 1985). To date, these studies are consistent in their findings. LI children appear to acquire lexical items in a normal manner. What is especially intriguing is the possibility raised by the findings of Leonard et al (1982) and Chapman et al (1983) that LI children may also acquire vocabulary at the same rate as normal children. A mismatch between a normal rate of acquisition on the one hand, and areas of lexical impairment on the other, may give rise to some of the production abnormalities noted in the lexical acquisition patterns of LI children (e.g., the concomitant use of early, semantically overextended words alongside semantically more restricted synonyms). This kind of lexical variation, where more advanced or fully specified lexical entries coexist and are used alongside less fully specified entries to express the same meaning, whether or not they arise as a result of a normal rate of lexical acquisition combined with more delayed lexical development in other areas, once again raises the possibility of deviance in the grammar. This, as well as all other areas of semantic representation and use, clearly needs further investigation.

#### e. Pragmatics

Although not technically part of the grammatical system, a major rule system interfacing with grammatical knowledge is the pragmatic system, the rules governing the use of language in context. In examining the nature of pragmatic function in LI children, the question of whether or not these children are more globally communicatively impaired can be addressed. In addition, in language development and mature use, form and function interact in important ways. It is of specific interest, therefore, to determine if children impaired in the acquisition of linguistic form are also impaired in the social and communicative functions of language.

Questions to be asked in this area include: 1) Do LI children exhibit normal patterns of communication; and 2) Are LI children able to use their linguistic knowledge in the service of communication in a normal fashion, that is, do they adequately and appropriately map their linguistic knowledge onto the rules of social discourse.

This area of investigation has seen a considerable growth in research attention. Prior to the last decade, the pragmatic abilities of LI children had yet to be explored. In the last decade, however, a multitude of studies

have been conducted on this general topic. The results to date are somewhat inconsistent.

One area that has been examined is conversational participation, that is, the ability to appreciate the reciprocal nature of conversation and to adequately and appropriately play both speaker-initiator and listener-respondent. Bartak et al (1975) found that unlike autistic children, LI children were quite skilled in their conversational participation, both as initiators and as respondents. Stein (1976), Watson (1977), and Sheppard (1980), on the other hand, found LI children to show somewhat restricted conversational participation, relying more heavily than other children on back channel devices. These findings indicate a lower degree of responsiveness and assertiveness in conversational interactions. Fey et al (1981), Jacobs (1981), Prelock et al (1981), Van Kleeck and Frankel (1981), Fey (1981), and Fey and Leonard (1984) support the early study by Bartak et al, finding that LI children do not exhibit deficits in conversational participation, especially when compared with children who are somewhat comparable linguistically. These latter studies reveal the importance of not confounding linguistic-pragmatic factors with factors such as age, cognitive maturity, personality, etc. They also point to the importance of separating the ability to perform certain pragmatic acts from the linguistic means with which those acts are performed. A more restricted range of linguistic devices for performing conversational acts may be expected in children who have linguistic deficits. They do not, in themselves, however, indicate pragmatic deficits. Curtiss and Tallal's (1985) findings from the San Diego longitudinal study support this contention. They found that the range of pragmatic acts children display in a conversational dyad can be extensive and comparable across LI and language-matched normals. Complicating matters somewhat, however, they also found that the degree of conversational initiative LI children display may depend on their particular performance strengths and weaknesses. Different expressive-receptive performance profiles were associated with different degrees of conversational initiative, which, it appears, may be more related to linguistic facility in handling particular situational contexts or tasks than to linguistic maturity, per se. What is more, this study suggests that pragmatic performance may change quite dramatically over time.

A second area of pragmatic function which has been investigated is the ability to regulate discourse, that is, the ability to provide feedback regarding your partner's communicative effectiveness. Watson (1977) found that LI children request clarification less than normal children. In contrast, Fey (1981) and Griffin (1979) report that LI children request clarification as often and use the same types of devices to do so. Most studies in this area, however, (e.g., Stein, 1976; Hoar, 1977; Gale et al, 1981) report that LI children are less versatile in the means by which they request clarification, consistently relying on the already given structure of the interlocuter's utterance to do so. These latter findings again point out the difference between linguistic limitations and pragmatic ones.

A third area of pragmatics studied has been speech act range, i.e., the set of functions that utterances are intended to serve. In general, findings in this area mirror those found in other pragmatic areas studied. When linguistic abilities are not considered (e.g., Geller and Wollner, 1976), LI children may

appear to be deficient compared to normal children. However, when linguistic and other potentially confounding factors are noted, no such deficits are found (e.g., Fey et al, 1978; Ball and Cross, 1981; Snyder, 1978; Curtiss and Tallal, 1985) although a more restricted set of linguistic means to express intention or function is again often noted.

Another pragmatic ability which, when investigated, has led to inconsistent results, is the ability to code switch, i.e., the ability to produce stylistic variations to suit the social situation. Fey and Leonard (1984) report that LI children failed to simplify their speech when talking to younger children. However, Shatz and Gelman (1973) and Sachs and Davin (1976) found that many young normal children also fail to make stylistic adjustments when talking to adults or babies. In contrast, Fey (1981), Fey et al (1981) and Messick and Newhoff (1979) found that LI children appropriately modify their speech to the age and status of their conversational partners.

The bulk of the evidence on pragmatic function seems to indicate that LI children are not globally, communicatively impaired. Specific task factors may give rise to the appearance of pragmatic deficits, but no pragmatic dysfunctions have consistently been demonstrated. As knowledge of pragmatic ability in the normal population increases, however, new areas to investigate are revealed. It may yet be the case, therefore, that LI children will be shown to have pragmatic deficits in addition to deficits in other areas already known to exist.

The studies of LI children detailed above reveal the important distinction between the mastery of rules of grammar on the one hand and the use or performance of this knowledge on the other. LI children differ from normal children and from each other in their ability to map their linguistic knowledge onto pragmatic acts. This distinction between linguistic knowledge and use is one that may be of major importance in characterizing the impairments that LI children display, as is made clear in considering the issue of linguistic subgroups.

#### f. Linguistic Subgroups

One finding that consistently arises in studies of LI children is that not all LI children perform similarly. Three subgroups are widely recognized, including: some LI children who comprehend significantly more than they produce (expressively impaired); some who speak remarkably well, given how poorly they perform on tests of comprehension (receptively impaired); and some who seem significantly impaired across the board, regardless of task or performance domain.

Although the three performance profiles referred to above define hallmark characteristics of LI children, key questions regarding the subgrouping of this population remain unanswered. For example, do LI children also fall into subgroups based upon nonlinguistic performance factors? (See Wilson et al, 1980 for a review of this area.) Are the classical subgroupings of LI children meaningful linguistically, that is, are the performance characteristics peculiar to each of these subgroups generalizable along grammatical lines? Are performance strengths and weaknesses, which define subgroup membership, con-



sistent over time, that is, are such subgroupings meaningful clinically?

Attempts to define subgroups along linguistic dimensions have recently been made (e.g., Nation and Aram, 1975; Wolfus et al, 1980). Such studies report a number of distinct patterns of linguistic abilities which distinguish among LI children and, thereby, suggest ways to define subgroups based on more detailed performance characteristics. Some of the results of these studies, however, are in conflict with each other. For example, in the Wolfus et al study, semantic performance did not correlate significantly with phonological ability, whereas the two areas did correlate significantly in the Aram and Nation study. Other results, though not conflicting, are difficult to interpret. For example, in both studies, syntactic production did not correlate significantly with semantic ability, but semantic and syntactic ability did correlate when receptive syntax was the relevant measure. Furthermore, both studies defined subgroups by performance mode deficits, yet the specific constellation of linguistic abilities correlating with these subgroups differed substantially in the two studies.

As part of the San Diego Longitudinal Study, Tallal and Curtiss (1980-1988), these questions pertaining to subgroupings are being investigated. Data from the first two years of this study yield some surprising answers (Curtiss and Tallal, 1985). In this study, LI children were classified into four subgroups, based on their standardized test performance at the time they were selected into the study: 1) receptively impaired, those children whose expressive language age exceeded their receptive language age by a minimum of four months; 2) expressively impaired, those children whose receptive language age exceeded their expressive language age by at least six months, but was within one year of their CA; 3) severely impaired, those children whose expressive and receptive language ages were both more than one year below their CA; and 4) mildly impaired, those children whose expressive and receptive language ages placed the child more than one year below his/her CA only when averaged together. All of the groups were compared each year longitudinally on their ability to comprehend and produce several different clusters of linguistic structures, each of which shared a particular linguistic structure or principle. There were two noteworthy results. First, the pattern of performance across clusters was the same for all of the subgroups. Even more interesting, however, subgroup 2 (the expressively impaired group) outperformed subgroup 1 on every cluster, regardless of the structural linguistic parameters involved. The quantitatively, but not qualitatively, different result obtained suggests that the impairment (or set of impairments) of both groups may be somewhat task-dependent and may lie principally in an area other than linguistic knowledge, per se, since the linguistic signal has the same properties regardless of which performance channels it must pass through. A major difference between these two groups, then, may be that subgroup 2's performance is enhanced or at least unimpeded by certain parameters of structured tasks, whereas subgroup 1's performance is compromised in the same circumstances. Second analyses point to the same conclusion.

In a second set of analyses, Tallal and Curtiss performed detailed linguistic and conversational analyses of free speech data from 30 of the LI children and 30 language-matched normals. The 30 LI children represented 10 children from each of the first three subgroups. First, detailed pragmatic analysis was

performed. The only significant difference found between subgroups was that in year 1 of the study, subgroup 1 (receptively impaired) showed significantly more conversational initiative than the other subgroups and the normal children. Aside from this difference, however, in the first two years of the study, the three subgroups did not differ significantly from each other, either in pattern or in level of communicative performance, across the numerous parameters evaluated. Second, in evaluating semantic performance, the use and appropriateness of 24 separate semantic roles or structures and semantic ability was examined. Despite the numerous opportunities for differences to be noted, only one significant difference between groups emerged. Subgroup 1 produced significantly more multipropositional utterances than subgroup 2. This was true in the first year (four-year-old) and second year (five-year-old) children in the study. Regarding syntactic performance, once again a rich variety of parameters were examined. At year 1 of the study, significant differences between subgroups were noted. Subgroup 2 used a significantly smaller range of syntactic structures than the other three groups, and subgroups 2 and 3 demonstrated significantly poorer control of syntactically complex structures and produced a significantly higher percentage of ungrammatical morphological and syntactic structures. By year 2 of the study, however, there were no longer significant differences between subgroups. Importantly, these results demonstrate that test performances which showed large expressive language differences between the different subgroups of four-year-old LI children did not translate into significant differences in syntactic, semantic, or communicative performance in spontaneous speech by age five. Moreover, even during the first year of the study, few differences between subgroups emerged, except in the area of syntax. These results again suggest that something other than knowledge of the linguistic system, per se, may be what is differentiating LI children so consistently into subgroups on the basis of standardized test performance. In support of this interpretation is the fact that production of specific linguistic structures was successful (well-formed) on one production task (sentence completion, for example), but unsuccessful (ill-formed or omitted) on another (spontaneous speech). Such differences appear to be related directly to the capacity to handle task-specific features, that is, to couple linguistic knowledge with particular linguistic requirements. Furthermore, although some children succeeded more often with sentence completion than on spontaneous speech, while others performed in the opposite pattern, children within the same subgroup generally appeared to perform similarly. These results are consistent with the hypothesis that the classical subgroupings of LI children relate to psycholinguistic and neuropsychological impairments in this population, rather than to factors pertaining to their acquisition of linguistic knowledge. These unexpected data, implicating neuropsychological rather than linguistic deficits as the potential basis of these classically recognized subgroups of LI children, make it imperative that we take even more seriously hypotheses that characterize LI children as having neuropsychological rather than linguistic deficits.

## 2. Neuropsychological (Perceptual/Motor) Characteristics

There is no doubt that LI children have difficulty with various aspects of linguistic processing and/or production. Deviation in the development of linguistic performance may be attributable to difficulty acquiring higher order semantic or syntactic rules. However, it is also possible that linguistic

deficits could result from more primary perceptual and/or motor problems, such as difficulty in detecting signal change, in discriminating temporal or spectral features, or in integrating or producing different aspects of complex signals over time. Such processes may be a necessary prerequisite to normal language function. Until we can effectively rule out malfunctions in these more primary perceptual and motor mechanisms, it will be extremely difficult to differentiate between disorders that may arise at different stages of language processing and production.

Clinical descriptions of LI children have consistently reported perceptual motor and memory deficits. These clinical impressions have been supported by numerous research studies (see Tallal, 1981, for review). The studies of Tallal and colleagues over the past 15 years have demonstrated highly significant and consistent nonverbal temporal, perceptual, motor, and memory deficits in LI children (Tallal and Piercy, 1973a, 1973b, 1974; Johnston et al, 1981; Tallal et al, 1981; Stark et al, 1983; Tallal et al, 1985, 1986;) These studies demonstrate that LI children are specifically impaired in their ability to discriminate as well as sequence rapidly presented nonverbal stimuli, and hence, remember them. For example, whereas normal children required only 8 msec between two 75 msec tones to respond correctly to their temporal order, LI children required, on average, 300 msec to even discriminate between the tones. This result, replicated in numerous studies using nonverbal auditory, visual, tactile, and cross-modal stimuli, demonstrates that LI children are specifically impaired in their ability to respond correctly to nonverbal sensory information that enters the nervous system quickly in time (simultaneously or in rapid succession), and that the amount of time required by LI children for sensory information processing is orders of magnitude greater than that demonstrated by normal children. Similar temporal deficits in nonverbal temporal motor planning have also been observed in LI children (Johnson et al, 1981; Tallal et al, 1985, 1986). It is important to emphasize that these highly consistent and significant deficits, characteristic of LI children are demonstrated for both processing and producing nonverbal temporal patterns. There are no significant differences between LI and normally developing children on other tasks of information processing and production not requiring rapid temporal integration, or even on the same tasks of temporal integration when stimuli are presented more slowly. Thus, this nonverbal temporal processing deficit is: 1) large in magnitude, 2) specific, and 3) highly replicable across populations of specifically LI children. Importantly, autistic children with articulation disorders (without language disorder) and children with reading disorders (without oral language disorders) have been shown to perform normally on temporal tasks (Starke et al, 1979; Tallal et al, 1980b). However, reading impaired children with concomitant oral language deficits (and decoding difficulties) did show this pattern of temporal perceptual impairment (Tallal, 1980).

The relationship between these nonverbal processing deficits and the verbal disorder of LI children was investigated by Tallal and Piercy (1974, 1975), who published data that provided, for the first time, a direct link between basic nonverbal temporal processing deficits and basic speech perception deficits in LI children. Using computer synthesized speech, which allows for precise control of the acoustic spectra of individual speech sounds, Tallal and Piercy demonstrated that LI children were specifically impaired in their

ability to discriminate and sequence precisely those speech sounds that incorporated rapidly changing acoustic spectra (stop consonant-vowel syllables). Importantly, these same children were unimpaired in their ability to respond correctly to speech sounds that were either steady state in nature (isolated vowels) or had been synthesized in such a way as to slow down the rate of acoustic change (stop consonant vowel syllables with extended format transitions). Thus, these studies demonstrated that LI children are not equally impaired in processing all speech sounds. Rather, they have specific difficulty processing only those speech sounds that are characterized by rapidly changing acoustic spectra which are critical for their discrimination (Tallal and Stark, 1981). Further study demonstrated that these children's errors in speech production were similar to their errors in speech perception. That is, those speech sounds that rely on brief temporal cues for their discrimination were not only most often misperceived by these children, but were also most frequently misproduced or omitted in their speech output (Stark and Tallal, 1979; Tallal et al, 1980a, 1980b). Based on these results linking a specific nonverbal temporal processing deficit directly to the pattern of speech perception and speech production deficits in LI children, Tallal hypothesized that basic neural deficits in temporal analysis and production may preclude or delay the development of normal speech perception and production and thus may impinge on normal language development.

In an NINCDS funded contract (1975-1979), Investigating the Sensory, Perceptual, and Motor Functioning of Children with Language Disorders, Reading Disabilities, or Articulation Disorders, Tallal and colleagues (Stark, Mellits, Kallman) investigated this hypothesis by assessing the degree of receptive language impairment in a large group of LI children. They hypothesized that if the specific temporal perception deficits of LI children were directly related to their receptive language impairment, then the degree of their perceptual impairment should predict the degree of their receptive language impairment. The results of multivariate analyses demonstrated a highly significant relationship ( $r = .89$ ,  $p < .001$ ) between the degree of temporal perceptual impairments and receptive language impairments in LI children. Importantly, this study demonstrated quantitatively that temporal perceptual abilities alone could account for over 80 percent of the variance associated with the receptive language deficits of LI children (Tallal et al, 1985).

Although specific developmental language impairment has clinically been defined primarily by exclusion, research has now provided reliable evidence of specific temporal perceptual/motor profiles which appear to be positively associated with LI children. The extent to which these specific temporal variables alone could correctly classify (diagnose) children as language impaired or normal was also addressed by Tallal and colleagues. The results of discriminate function analyses indicated that a combination of six perceptual and motor variables, when taken in combination, could classify correctly 98 percent of the subjects studied as either normally developing or language impaired. These six variables included: 1) rate of multi-syllabic word production; 2) discrimination between speech syllables, incorporating brief format transitions; 3) discrimination of simultaneous touches to the fingers; 4) cross-modal (auditory-visual) integration rate; 5) visual integration rate; and 6) double simultaneous tactile stimulation to the hands and/or cheek.



These variables had in common the need to perceive or produce basic sensory information quickly in time. Using these six variables alone, Tallal and colleagues were able to correctly classify 31 of the 32 LI children participating in the study as language impaired, and all 36 of the control subjects as normal. Importantly, none of these variables assessed what are commonly considered higher level linguistic functions or used standardized language assessment procedures used clinical to assess language impairments.

The results of this now large series of studies demonstrate that a specific temporal perceptual/motor mechanism is grossly impaired in LI children. The degree of temporal perceptual/motor impairment is: 1) highly predictive of the degree of receptive language impairment in these children; 2) appears to co-occur in the vast majority of children with specific developmental language disorders; and 3) may well be a "marker variable" for language impairment.

### 3. Reading Profiles

Importantly, reading impaired children with concomitant oral language disorders, as well as specific decoding (phonics) deficits, have also been shown to manifest a similar pattern of neuropsychological deficits to those described for LI children (Tallal, 1980a, 1980b). However, reading impaired children who do not have concomitant oral language deficits or difficulty learning phonetic rules, do not show these specific temporal perceptual/motor deficits (Tallal and Starke, 1982). Thus, Tallal has hypothesized that a specific neurological mechanism may disrupt phoneme perception and production resulting first in delayed language acquisition in young children and subsequently in delayed reading acquisition in older children. This hypothesis suggests that certain developmental language disorders and developmental reading disorders may result from the same underlying neurological deficit and may differ only in the age of the child and the learning skills being acquired at different ages.

Recent results from the NINCDS-funded San Diego Longitudinal Study Evaluating the Outcomes of Early Language Impairments in Children (Tallal and Curtiss, 1980-1988) support this hypothesis. These results demonstrate the remarkable predictive outcome of early language impairment (developmental dysphasia) to subsequent reading impairment (developmental dyslexia). Preliminary results of this longitudinal study demonstrate that, based on discriminant function analysis, by age six years, 78 percent of the LI subjects can be correctly classified based on their spelling scores, 86 percent based on their reading vocabulary scores, and 87 percent based on their reading comprehension scores. By age 7 years, 75 percent of the LI subjects are correctly classified based on spelling scores alone, 81 percent on reading vocabulary, and 80 percent on reading comprehension. Similar results have been reported in all previous longitudinal studies reporting a high incidence of dyslexia in children with early language impairments. (Stominger and Bashir, 1977; Hall and Tomlin, 1978; Aram and Nation, 1975; Silva et al, 1980, 1983; Stark et al, 1984).

Longitudinal studies directly demonstrate the co-occurrence of developmental language disorders and developmental reading disorders in the same children at different ages. Nonetheless, these disorders continue to be defined, diagnosed, conceptualized, and treated as distinct clinical and research

entities. This is evidenced by the separation between professionals serving language impaired and reading impaired children, both in their clinical and their theoretical training. Whereas speech pathologists and audiologists serve language impaired children, special educators and reading specialists serve reading impaired children. Conferences on developmental dysphasia (developmental language disorders) rarely include papers on developmental dyslexia (reading impairment) and vice versa. Significantly, even the National Institutes of Health have two separate agencies for overseeing research on these populations. Whereas language impairments (aphasia) fall under the auspices and responsibilities of the NINCDS, research on reading impairments (dyslexia) falls within the domain of the NICHD. Similarly, the DSM-III classifies developmental language and reading disorders separately. The results of longitudinal research studies, however, clearly demonstrate that it may be the age of the child rather than the neurological basis that differs between developmental language and developmental reading disorders. Continuing to separate these developmental communication disorders ultimately fails the many children who "progress" from language to reading impaired. Although not all reading impaired children have concomitant oral language deficits, (Tallal et al, 1986) these research suggest that a very high percentage of LI children have some degree of delayed reading acquisition. It is suggested that to continue to separate these disorders potentially impedes progress toward the eventual treatment and prevention of these communication learning disorders.

#### 4. Cognitive Characteristics

For more than 20 years, LI children have been operationally defined as having normal nonverbal intelligence and normal cognitive capacity. The conclusion that LI children had normal nonlinguistic cognition probably arose because, in order to make differential diagnoses of specific language impairment, as opposed to mental retardation, children had to perform within normal limits on nonverbal portions of standardized intelligence tests. Research on this point remains controversial, however, with some studies suggesting that LI children may exhibit deficits and/or delays in nonlinguistic areas of cognition, and others refuting this interpretation.

LI children have demonstrated difficulties with many different nonverbal aspects of cognition: means/ends knowledge, that is, what children do to obtain objects or to cause actions (Snyder, 1978); interpreting and drawing inferences from visually depicted events (Mackworth et al, 1973; Otto et al, 1973); classification (Johnston and Ramstad, 1978); figurative thought (thought involving visual mental representations), including haptic problem-solving, seriation, and mental rotations (Kamhi, 1981; deAjuriaguerra, 1976; Weismer, 1983); rule and hypothesis formulation (Kamhi et al, 1984); and short-term memory processes, especially with respect to parameters relating to memory capacity (e.g., Kircher and Klatzky, 1985).

On the basis of this and other research, some researchers have hypothesized that LI children do not have a selective language deficit, but have a more general representational deficit which underlies both their linguistic and nonlinguistic difficulties (Morehead, 1972; Morehead and Ingram, 1973; Inhelder, 1966, 1976; deAjuriaguerra, 1976). The finding that LI children exhibit deficits in representational abilities across a range of tasks and at

different points in development is consistent with such a view. Such deficits could explain some of the specific impairments noted in the language development of this population. For example, the delay in speech onset, the protracted rate of lexical acquisition, the impoverished range of semantic functions and relations expressed, and the limited propositional complexity of speech could all be the linguistic reflections of representational and conceptual impairments. Moreover, a deficit in rule formulation and hypothesis testing could have equally significant negative consequences for language acquisition.

Such conclusions are premature, however. First, many investigations of nonlinguistic cognition in LI children have failed to find any such deficits in this population. (See Stark et al, 1983, for review.) Studies of the symbolic play of LI children have produced equivocal results (e.g., Lovell et al, 1968; Terrell et al, 1984) as have investigations of operative thought (e.g., Inhelder, 1966; Johnston and Ramstad, 1978). In addition, several of the studies cited above, which purported to find evidence of nonlinguistic cognitive deficits of LI children, presented data from which alternative conclusions could easily be drawn. For example, Johnston and Weismer (1983) concluded that LI children possess an impairment of visual imagery, even though these children did not differ significantly from control children either in the accuracy of their judgements, or in the number of training trials needed to reach criterion on a mental rotation task. The LI children did respond significantly more slowly on the task, implying simply that such children were motorically slow. In another study, Kamhi (1984) concluded that LI children evidence deficits in hypothesis testing ability and in nonlinguistic symbolic abilities. The data simply do not support these conclusions. LI children performed normally on a concept acquisition task and on a discrimination learning task (in terms of number of trials needed to reach criterion). However, significantly more LI children than controls were unable to verbalize the correct solution to this latter task, hardly a surprising result given that these are, by definition, language impaired children. The LI children also performed significantly worse on a haptic recognition test, from which the authors concluded that such children possess a general problem with symbolic representation. Clearly, a more parsimonious explanation for these data would be that the LI children have a problem with cross modal sensory integration (in this case, tactile sensation-visual recognition) as reported by Tallal et al (1981).

Second, both theoretical linguistics and psycholinguistics support the contention that linguistic and nonlinguistic rules and representations may differ considerably (e.g., Chomsky, 1980; Curtiss, 1982, in press; Demopoulos and Marras, 1986). Therefore, there is no a priori reason to assume that a child with linguistic representational difficulty would necessarily also have nonlinguistic representational difficulty.

Third, not all LI children evidence nonlinguistic deficits; in almost every study cited, at least some of the LI children performed normally on nonlinguistic, cognitive measures. This indicates that LI children do not comprise a single, homogeneous population. Therefore, the fact that many LI children manifest a range of developmental dysfunctions which could impair their language acquisition does not preclude the possibility that a subgroup of these children have a truly selective linguistic deficit.

There is currently no conclusive evidence as to whether the various cognitive deficits that LI children demonstrate stem from a single underlying impairment, or whether they are causally related. However, an investigation into possible relationships between the linguistic and nonlinguistic cognitive deficits in these children would be germane to at least two important issues in the cognitive sciences: First, are language, mental imagery, and other symbolic abilities separate faculties of mind, embodying distinct cognitive principles, or are they different manifestations of a single set of cognitive principles? Second, which perceptual and/or cognitive abilities are prerequisites for language acquisition? Because the LI child commonly shows perceptual as well as cognitive deficits, a rigorous examination of linguistic, cognitive, and perceptual function, in the same impaired population, could provide crucial evidence on the fundamental relationships between language development and aspects of cognition and perception which are not strictly linguistic. The first such study, wedding linguistic, cognitive, and neuropsychological investigations of the same population, is currently underway as part of the San Diego Longitudinal Study (Tallal and Curtiss, 1980-1988).

#### 5. Social-Emotional Characteristics

Investigating the role that language may play as a mediator in emerging social and emotional development in children has occupied a central position in the field of developmental social cognition. With the development of language, it has been suggested that the child gains a new and powerful means of classifying logical connections and developing reasoning skills that enable him/her to differentiate emotional and conceptual domains and gain mastery within them (Hasaibi and Breuer, 1980).

Thus, it might be expected that serious developmental language impairment could have a profound impact on social and emotional development. Indeed, LI children offer a unique opportunity for evaluating the potential relationship between emerging language (or lack thereof) and social and emotional development. However, despite the potential for studying this important developmental issue, until recently few empirical studies of the social and emotional status of LI children have been reported. This is obviously a fruitful area for continued research.

The studies of Cantwell et al, 1980, and Baker et al, 1980, provide perhaps the most comprehensive review and new information on the relationship between speech and language disorders and psychiatric disorders in children. These authors report the results of a comprehensive psychiatric evaluation of 100 consecutive cases of children seen in a community speech and hearing clinic. Psychiatric diagnosis of this cohort revealed the presence of a diagnosable psychiatric disorder, according to DSM-III criteria, in approximately 50 percent of the group studied. It is important to note, however, that included as "diagnosable psychiatric disorder," were diagnoses of developmental disorders such as reading and math deficits and attention deficit disorder. Baker et al (1980) reported a differential degree of these disturbances in children with various linguistic profiles. Children with speech articulation problems, without concomitant language disorders, were found to show the least prevalence for these DSM-III diagnoses. Children with speech and language dis-



orders or language disorders alone were most at risk for these DSM-III diagnoses.

Approaching the association between emotional and speech disorders in children from another direction, Chess and Rosenberg (1974) evaluated the incidence of speech disorders among children referred for psychiatric treatment. They found that over a three-year period, 24 percent of all children referred for psychiatric therapy had some type of language disorder. Psychiatric diagnoses for these children included cerebral dysfunction, developmental lag, thought disorder, and neurotic behavior disorder. However, these authors suggest that without longitudinal studies assessing the relationship between language and social-emotional development in children, it would be difficult to determine whether emotional disorders are primary or whether the resultant stresses of language delay themselves create a high probability of secondary compensatory behaviors, such as withdrawal or other kinds of intrusive actions. These authors suggest that these protective and defensive maneuvers may be more easily noted and referred for treatment than the speech or language problem, and, in fact, the speech or language problems may often be wrongly misunderstood as derivative and secondary to an underlying neurotic mechanism, rather than vice versa.

In addition to a longitudinal design, issues pertaining to direction of causality might be addressed by looking specifically at very young children. Stephenson and Richmond (1978) report the only study that has focused on the preschool age child. These authors conducted a comprehensive epidemiological study of three year olds living in a London suburb. They found that, of the random sample of 700 children studied, 14 percent displayed behavioral problems. However, 59 percent of the children with language delay displayed behavioral problems. Unfortunately, it is not clear from this study that only children with specific developmental language delay were included in the LI group or whether age was a relevant factor. Children with language delay secondary to other developmental disabilities such as general mental retardation, social deprivation, hearing loss, or infantile autism, were also represented in the population. Thus, the extent to which behavioral problems are associated with these other developmental disabilities cannot be parceled out from those associated specifically with language disabilities. This methodological criticism, unfortunately, must be applied to all of the studies previously reported and reviewed here. Similarly, even the most recently published study on the topic (Bietchman et al, 1986) fails to distinguish specific developmental language impairment from language delay which is secondary to mental retardation, infantile autism, hearing loss, paralysis or malformation of the oral musculature, or frank neurological insult or acquired aphasia.

As part of the NINCDS-funded Longitudinal Study of the Outcomes of Early Language Impairments in Children, Tallal et al (1986) report the prevalence of social and emotional disturbance in preschool age LI children. This study differs methodologically in three important ways from previously reported studies in the literature pertaining to social and emotional sequelae of developmental language disorders: 1) only four-year-old children who had only recently been diagnosed as specifically language impaired were included; 2) subjects were rigorously tested to quantitatively establish that they were both sig-

nificantly language impaired and that the impairment was specific to expressive and/or receptive language only; (Children with speech problems only or other neurological, mental, or physical problems were excluded.) and 3) a well-matched control group was included. The results of this study also differ from those reported previously. Using a standardized Child Behavior Checklist (Achenbach, 1979, 1980, 1982), it was found that although the mean and standard deviations were significantly different for the Total Scores between the normal and LI group, further analysis demonstrated that only one of the eight individual Behavior Scales, developed by Achenbach from this checklist, contributed to this significant difference. Similarly, using Achenbach cutoff of a T-score of 70 or higher to represent clinically abnormal behavior, none of the 49 normal subjects and only five of the 81 LI subjects participating in the study demonstrated abnormality at this level, an insignificant difference. The one scale that did significantly differentiate the LI from the normal children (immaturity for the boys and social withdrawal for the girls) on further inspection revealed a high number of neurological as opposed to purely emotional items. These included items such as speech problems, confused, clumsy, can't concentrate, won't talk, twitches, and accident-prone. Discriminate function analysis demonstrated that these neurological items from the Achenbach Child Behavior Checklist accounted for the significant majority of variance between groups found for the Total Behavior scores. Ninety-two percent of the boys and 90 percent of the girls could correctly be classified as LI as opposed to normal, based on these neurological items from the Achenbach scale, without resorting to the inclusion of the more specifically social or emotional items from this scale.

The results of this recent study demonstrate that four-year-old LI children are not significantly different than age-match controls in social and emotional development, in areas other than reflect neuropsychological integrity. However, when items assessing aspects of neuropsychological functioning are included in standard child behavior checklists, the overall results demonstrate significant differences between Total Behavior scores obtained between group which, without more detailed analysis, may be misinterpreted as social and emotional disturbance. It is important that interpretations pertaining to social and emotional disorders in LI children, based on parent, teacher, or clinical observation, not be confounded with aspects of behavior which may be associated with the originally diagnosed neurological disorder. It will be important to replicate these findings using other techniques, including clinical observation and other standardized methods. It will also be of particular interest to reassess these same children at the end of the longitudinal study (at age eight) to determine whether or not changes have occurred in the social and emotional profiles of LI children assessed in the preschool and subsequently the mid-elementary school years. Although these results suggest that specific developmental language delay is initially neurological rather than emotional in origin, it is possible that these children develop emotional disturbances with increasing age, perhaps as a result of attempting to cope with the stresses produced by their language and learning disabilities.

#### Summary and Limitations: Goals for Future Research

Three major points arise from this discussion of definition and associated

characteristics of specific developmental language disorders:

1) Although important similarities may exist between children with specific developmental language disorders and those with language disorders secondary to other developmental disabilities (mental retardation, hearing loss, autism, cerebral palsy, acquired aphasia, articulation disorders) research has been highly confounded by a lack of careful attention to separation between these different developmental disabilities. Until consistent, standardized inclusionary and exclusionary criteria for selecting subjects for studies of specific developmental language impairment are both established and uniformly applied, it will continue to be virtually impossible to generalize research results from one study to the next and to make progress in our understanding of specific developmental language delay. It is suggested that the number one priority for research would be the development of these standardized inclusionary and exclusionary criteria and the requirement of their uniform usage for subsequent federally or privately funded research in this area.

2) Somewhat paradoxically, there seems to be a higher tendency to merge children with language disabilities which appear to arise from very different etiologies (mental retardation, hearing loss, autism) into a single category for study and treatment than children with primary communication-learning disabilities (specific developmental language disorder and specific developmental reading disorder). Research now strongly documents that for many of these children, their language and reading difficulties may result from similar neurological etiology, manifesting itself differently at different stages of development. It is suggested that future research be focused at investigating similarities and differences between children with a variety of developmental disabilities concentrated more directly on etiology and mechanism rather than surface symptomatology. Continued classification based primarily on symptomatology rather than etiology and mechanism may directly impede progress in research and treatment of learning impaired children.

3) The continued adherence to definition by exclusion, in light of the plethora of new information emerging from research pertaining to inclusionary associated characteristics of LI children impedes progress in this area. It is distressing that the DSM-III (1980) adopted a virtually identical definition of specific developmental language disorders to that published by Benton over two decades ago, suggesting incorrectly that no progress has been made in the ensuing two decades. However, research activity has produced considerable advancements in our knowledge of the definition and associated inclusionary characteristics of children with specific developmental language impairment, particularly pertaining to neurological, neuropsychological, (particularly temporal perception and production), linguistic, cognitive, and social and emotional profiles. Many of these profiles have been shown to be highly reliable and replicable across many laboratories and groups of subjects. For example, although many different subgroups or profiles of children with language disorders have been identified, temporal/perceptual motor deficits have been shown to both accurately predict level of receptive

language impairment and classify 98 percent correctly LI from normal children, regardless of their subtype. It is, therefore, unacceptable to continue to adopt a diagnosis based solely on what is not known about LI children, in deference to including in the definition of the disorder what is currently known to characterize these children.

## II. Diagnosis

The issue of diagnosis is closely related to that of definition and associated characteristics. For appropriate diagnosis to be made, the inclusionary and exclusionary criteria based on the definition of the disorder needs to be operationalized and standardized so that consistency in making differential diagnoses across laboratories and clinics can be established. Once inclusionary and exclusionary criteria have been 1) established, 2) standardized, and 3) uniformly adopted, it must be determined which testing procedures are most appropriate for validly and reliably assessing each aspect of the child's behavior needed to determine these criteria. It is suggested that this section on diagnosis be read in conjunction with the previous section on definition and associated characteristics. This section will focus on issues pertaining to testing and assessment.

The differential diagnosis of specific developmental language delay can be conceptualized as a three-tiered process: 1) establishing that the child is demonstrating significant delay in developing language at or near the expected age; 2) determining whether the language delay is the primary disorder or secondary to other developmental disabilities, (i.e., hearing loss, mental retardation, autism); and 3) determining the nature of the language disorder and its associated characteristics, (subtype) i.e., receptive and/or expressive language disorder, with or without concomitant articulation disorder, perceptual/motor impairments, memory disorder, emotional disturbance, academic achievement problems.

Determining that language development is significantly delayed in a child directly depends on our understanding of the stages and time course of normal language acquisition. This obvious necessity is, nonetheless, often overlooked in the training of professionals to whom the diagnosis of language impairments in children often falls. Specifically, neurologists, psychiatrists, pediatricians, and even teachers have little or no direct training in normal developmental psycholinguistics and neuropsychology, or speech pathology. Having little or no training in normal language development, it is not surprising that these professionals consistently misinform parents about the seriousness of their concerns pertaining to their child's language development and the need for referral to a speech pathologist, audiologist, and neuropsychologist for appropriate assessment and diagnosis. However, even the enlightened physician or teacher who does recognize a potential language impairment and refers to an appropriate professional for assessment and diagnosis can be easily frustrated and/or misled by the results of standardized speech and language assessment. Berk (1984) points out that standardized measures of language are among the worst psychometric tests with respect to reliability and validity.



## A. Language Testing

When children are brought into a clinic because of a suspected language-learning problem, the first order of priority for the clinician is to determine whether or not a speech or language problem exists, and to characterize the problem if one does exist. To accomplish this task, systematic methods for assessing or in some way "measuring" speech and language are required. For many years, language sampling procedures were relied upon, but in the last 25 years an abundance of formal language assessment instruments have been developed and become available for this purpose. Some of these tests focus on the assessment of abilities hypothesized to underlie or be requisite to language acquisition (e.g., auditory perception and memory, representational gesture, etc.) rather than on speech or language itself. Some tests focus on particular speech or language abilities and/or modalities of performance (e.g., articulation, receptive vocabulary, comprehension of syntax, expressive morphology). Still others have a more comprehensive focus, testing different components of linguistic knowledge across performance modalities (e.g., production and comprehension of vocabulary, morphology, or syntax). Some of the more well-known and widely used tests include the Illinois Test of Psycholinguistic Abilities (ITPA; Kirk et al, 1968), the Peabody Picture Vocabulary Test (PPVT; Dunn, 1959), the Berry-Talbott Exploratory Test of Grammar (Berry, 1966), the Assessment of Children's Language Comprehension (ACLA; Foster et al, 1969), the Northwestern Syntax Screening Test (NSST; Lee, 1970), the Test of Linguistic Development (TOLD; Newcomer and Hammill, 1977), the Test for Auditory Comprehension of Language (TACL; Carrow, 1973), the Carrow Elicited Language Inventory (CELI; Carrow, 1974), the Token Test (De Renzi and Vignolo, 1962), and the Clinical Evaluation of Language Functions (CELF; Semel and Wiig, 1980).

There is seemingly no lack of tests for the clinician to use. Indeed, such tests continue to proliferate. The use of these tests is routine and assumed essential for the identification and diagnosis of language disorders. Careful examination of tests currently available, however, reveals serious shortcomings from both a psychometric and a theoretical linguistic perspective. McCauley and Swisher (1984), Spekman and Roth (1984), and Lieberman and Michael (1986), for example, point out numerous test flaws across a wide range of speech and language tests, flaws which hold true equally for tests not examined by these authors. Serious psychometric flaws include, for example, inadequate normative samples and test reliability, and failure to achieve a test validity in most if not all respects. Most serious among inadequacies are a failure to demonstrate construct validity--the degree to which a test measures the theoretical construct it is intended to measure--content validity--the extent to which, when judged by an expert the test provides relevant information about the behavior being tested--criterion-related validity--the degree to which performance on the test in question is related to some other measure of the behavior being assessed--or reliability--the consistency with which a test measures a given behavior or ability.

Inadequacies in content and construct validity translate, in linguistic terms, into the absence of a theoretically grounded approach for analysis of linguistic abilities. The consequence of using an assessment instrument whose design is not informed by any theory of language, is that it is difficult if not im-

possible to know what the information gathered from such assessment means. Unless the practitioner using the test has the necessary expertise to construct the larger picture, as it were, a child's test scores, even details or profiles of test performance, may leave most questions concerning the child's disorder unanswered. This shortcoming on the part of most available language tests is reflective of a problem for the field in general, which, in large part, has proceeded uninformed by linguistic theory. In spite of the large number of language assessment tests currently on the market, there is still a need for new, carefully designed, theoretically grounded language tests which can differentiate a child with a language disorder from a linguistically normal child by virtue of either a significant developmental delay in linguistic growth, or an abnormal pattern of linguistic growth. Such tests will need to be comprehensive in scope, testing each component of linguistic knowledge (semantics, morphology, syntax, phonology) across linguistic activities and performance modalities, in ways that are appropriate and relevant for all the years of language acquisition. They will also need to reveal not only level of performance, but detailed patterns of performance, such that the acquisition of specific linguistic rules and general principles of grammar are both revealed. There is also a need for tests to assess the ability of the child to make use of her/his linguistic knowledge in the service of communication.

Finally, it cannot be over emphasized the importance of valid, reliable standardization of language tests across large populations of children. Because both the pattern and time course of language has been shown to differ dramatically in normally developing children (See Stark et al, 1982, for review.) it is essential that appropriate norms be established if reliable diagnosis of language impairment in children is to be made. Based on these norms, critical decisions pertaining to school placement and treatment are made that will potentially affect the child's ultimate development. It is a disgrace that these essential decisions are currently being made based on tests which lack validity and reliability and are so poorly normed. Only with psychometrically valid tests that are both broad and in-depth in their investigation of communicative and linguistic function and that are based on well-established normative data can a language disorder be adequately identified or characterized.

The validity and reliability of different test procedures (imitation, sentence-completion, object manipulation, picture-pointing, etc.) for revealing a child's linguistic or communicative competence is also a much discussed and important topic. The issue involves whether or not a particular task may consistently incorrectly estimate a child's linguistic abilities, perhaps because of memory or other processing factors involved in the task or because of the non-linguistic cognitive load it imposes. We will not enlarge upon these questions here, but for some interesting and informative discussion on this topic, see, for example, Slobin and Welsh, 1973; Prutting et al, 1975; Daily and Boxx, 1979; Connell and Myles-Zitzer, 1982; Lust et al, in press; and Hamburger and Crain, 1982, 1984.

Despite the numerous problems with testing and available tests, the clinician must nonetheless make an evaluation of a child's language. The importance of including a language sample as part of the assessment procedure is now widely recognized, and in the hands of a skilled practitioner, can be used to great benefit in evaluating, at a minimum, the expressive language and communicative

performance patterns of a child. This must be used in conjunction with a well-designed formal language test. A promising, soon-to-be-published candidate, which has been used very successfully in the San Diego longitudinal study and which is currently being normed with LI and normal children between the ages of two to nine years as part of this study, is the CYCLE (Curtiss and Yamada, to appear). Articulation tests, and other carefully designed and relevant non-language perceptual, motor, memory and cognitive tests, also must be included in the diagnosis of language disorders. Test development and standardization based on the principles discussed in this section is also critically important for assessing associated characteristics of LI children in a reliable manner.

## B. Differential Diagnosis

Once it has been established that a child is delayed in language development, it is important to determine whether the language delay is the primary disability or the symptom of a more primary developmental disability such as hearing loss, mental retardation, deformity or paralysis of the oral musculature, or autism. Assessment by an audiologist, child psychologist, speech pathologist, pediatric neurologist, and psychiatrist are in order to rule out these other disabilities as the primary cause of the language disorder. Again, standardized, valid and reliable procedures are needed for assessment of hearing, oral-motor integrity, and psychiatric disturbance in young children. These areas will not be discussed in detail in this report. However, due to its importance to the appropriate differential diagnosis of developmental language disorder, particularly as it is differentiated from mental retardation, issues pertaining to intelligence testing of potentially LI children will be discussed.

Specific developmental language delay is, by definition, a disorder that is specific to language development and thus must be differentiated from more general mental retardation. Therefore, it is essential that in addition to demonstrating that language abilities of a child are significantly below that which would be expected based on his/her chronological age, it is important to establish that they are also significantly discrepant from that which would be predicted based on the child's mental abilities. Thus, the child who demonstrates language and general cognitive abilities that are both significantly, but equally, behind her/his chronological age would not fit the diagnosis of specific developmental language impairment, as language in such cases cannot be demonstrated to be discrepant from other mental capacities. It is, therefore, critical that the assessment of intelligence and language not be confounded. That is, for children suspected of language disorders, intelligence tests that have been developed to assess intelligence without the need for understanding complex verbal instructions or for giving verbal responses must be utilized. For a child with specific developmental language delay who is given an auditory verbal, language-loaded intelligence test such as the Stanford-Binet (Terman and Merrill, 1973), the McCarthy Scales of Children's Ability (McCarthy, 1970) or the Peabody Picture Vocabulary Test (Dunn, 1959), the resultant IQ score will reflect the child's language disorder, not necessarily the child's cognitive abilities. According to Wilson (1986), the LI child may do very well with visually mediated cognitive and visual-constructional tasks, but a measure such as the Stanford-Binet IQ score, which is heavily verbally loaded, does not appropriately reflect such a child's cog-

nitive or conceptual abilities, as they are masked by the linguistic demands required by such tests to demonstrate cognitive and conceptual abilities. Wilson and Wilson (1977) compared IQ scores obtained from preschool LI children based on the Stanford-Binet, the McCarthy Scales of Children's Abilities, the Hiskey-Nebraska Test of Learning Aptitude (Hiskey, 1966) and the Pictorial Test of Intelligence (French, 1964). The mean IQ scores increased significantly and systematically across the four tests as language loading on the tests decreased. The mean IQ of the LI group ranged from 62 on the Stanford-Binet to 92 on the Pictorial Test of Intelligence. Thus, based on the selection of the intelligence tests used to assess cognitive ability, the same child could be diagnosed as mentally retarded or specifically language impaired, depending on the extent of verbal loading incorporated in the intelligence test. Thus, it is inappropriate to use language-based tests such as the Stanford-Binet, the Verbal or Full-Scale IQ score of the Weschler Intelligence Scales for children (Weschler, 1963) or the Peabody Picture Vocabulary Test to determine intelligence or mental age of a child demonstrating delayed language development. Tests not requiring comprehension of complex verbal instructions or verbal responses such as the Leiter International Performance Scale (Leiter, 1940), the Ravens Colored Progressive Matrices for Children (Raven, 1965), the Hiskey-Nebraska Test of Learning Aptitude, or the Performance Scales of the Weschler Intelligence Scales for Children, must be used for assessing intelligence in these children. Using such nonverbal tests of intelligence, it is necessary to demonstrate a discrepancy between developmental language age and both chronological and mental age for a diagnosis of specific developmental language disorder. Similarly, significant discrepancies between intelligence scales, with performance (non-verbal) IQ outstripping verbal IQ, are indicative of specific developmental language delay.

Just how discrepant must a child's language development be from chronological and mental age to consider the discrepancy diagnostic of a specific language disorder? Concomitantly, is degree of discrepancy at one age or developmental stage equally significant to the same degree at another age? For example, is a discrepancy of a year between mental age and language age in a four year old synonymous with a similar one-year discrepancy in an eight year old? Is it more appropriate to use: 1) a cut off score, for example, two standard deviations from a given mean score; 2) degree of deficit, for example, language age more than one year below chronological or mental age, or 3) language quotient, for example, language age less than 75 percent of chronological age? These issues have not been investigated, and there is no established, uniform procedure used either clinically or for research. Again, this lack of uniformity pertaining to such a basic diagnostic issue impedes progress in both research and clinical treatment for LI children.

### C. Patterns of Language Disorder

Once it has been established that: 1) a child is significantly delayed in language acquisition; and 2) a differential diagnosis has been made establishing that the impairment is specific to language; then 3) the pattern of language disorder and accompanying characteristics can be assessed. Standardized clinical tests can assess receptive (comprehension) aspects of language separately from expressive (production) aspects. Articulation impairment can also be assessed separately from receptive and expressive language disorder. Although



there are many tests that claim to assess auditory discrimination, auditory perception, and auditory memory functions in children, these tests uniformly suffer because they confound verbal and nonverbal auditory abilities. As each of these tests utilize words as stimulus material, it is not possible to distinguish verbal from nonverbal discrimination, perceptual, and memory deficits using these procedures. Nonverbal perceptual, memory, and motor testing procedures, such as those developed by Tallal (1980) for use in research with LI children, need to be developed and standardized for clinical diagnostic use if these important neuropsychological components (prerequisites) of language impairments are to be assessed separately from language skills, per se. Similarly, methods for assessing social and emotional disturbance in children, that do not confound language, learning and/or other neuropsychological symptomatology with psychiatric disorders, must be developed and standardized for clinical and research use with LI children.

### III. Prevalence

In a recent review of prevalence of speech and language disorders in children, Beitchman et al (1986) state that "despite speech and language disorders being increasingly recognized as a major health problem among young children, known to antedate serious psychosocial problems and academic failure, there are still no reliable data on the prevalence of speech and language disorders among school-age children." As Beitchman further points out, this obvious dearth of prevalence information is the direct result of the lack of a comprehensive, uniformly applied classification system for speech and language disorders. The literature is very confusing in the area of prevalence of language disorders, as speech, language, hearing, and mental retardation are often lumped together in developing these prevalence estimates. Tuomi and Ivanoff (1977) assessed the prevalence of speech, as well as language and hearing disorders in kindergarten and first grade children. They found the prevalence of articulation problems to be 25 percent in kindergarten children and 17 percent in first grade students. Fundudis et al (1979) conducted a study of speech delayed and deaf children in England. Assessing for only severe forms of delay, these authors report a 4 percent prevalence. Stevenson and Richman (1976) found the prevalence of expressive language delay to be 3 percent and severe expressive language delay to be 2 percent in their three-year-old London population. However, between 40 and 50 percent of the same children were mentally retarded. Combining speech and language delay together, Williams et al (1980) found that 14 percent of males and 8 percent of females had speech and/or language difficulties. Nine percent had mild impairment, while 2 percent were severely impaired. Silva (1980) reported that 3 percent of his sample of three-year-old children in Dunedin, New Zealand, were delayed in verbal comprehension, 2.5 percent were delayed in verbal expression only, and 3 percent were delayed in both. Beitchman concludes his review of prevalence of speech and language disorders in children as follows:

"It should be clear from the studies of the prevalence of speech defects and language delays-disorders reviewed that serious methodological problems render the validity of the existing data questionable. Non-representative samples, lack of clearly defined criteria for the definition of cases, absence of trained staff and standardized methods, with no evidence of reliability between raters are examples of the problems

that have bedeviled existing studies." (p. 100)

Beitchman attempted to address these methodological problems in a major prevalence study in Ottawa-Carleton, Canada. Using a one-in-three stratified random sample procedure of all five-year-old English-speaking kindergarteners from the Ottawa-Carleton region, children were screened in a three-stage procedure by professional staff. Stage one was a speech and language screening. All children scoring below the stage-one cutoff, as well as a small random sample of those scoring above the cutoff, were asked to participate in more extensive testing in stage two. Only those children scoring below the stage-two cutoff points were identified as speech or language impaired. These children, as well as the control sample, participated in stage three testing. Using standardized receptive and expressive speech and language tests, as well as a checklist for voice disorders, stuttering, and dysarthria, the following results were obtained: Of the 1,655 children sampled, 315 failed stage one. All but 14 (301, 184 boys and 117 girls) agreed to participate in stage-two testing. Of these, 175 (58 percent) failed at least one of the tests in stage two and went on to stage 3.

Significantly, the highest percentage of failure at stage 3 testing separating LI from normal children occurred on the Goldman-Fristoe-Woodcock (1974) test for memory for auditory sequence (44 percent failed). Surprisingly, only 18 percent failed the memory for verbal content portion of the same test. Failure for memory for auditory sequence was consistently higher than that for any other subcomponent of language assessed. Language measures ranged from a low of 0.3 percent, failing the grammatical completion portion of the Test of Language Development (Newcomber and Hammill, 1977), to a high of 32 percent failing the spoken language portion on the same test. Thus, the single most powerful indicator of speech and language disorders in this prevalence study was found to be failure on a test of memory for auditory sequence. These results are consistent with those reported by Tallal et al (1985) that demonstrated that temporal, perceptual/motor deficits are both highly predictive of level of receptive language impairment and discriminate between LI and normal children 98 percent correctly.

The overall prevalence of speech and language disorders reported by Beitchman et al (1986) was found to be 19 percent, plus or minus 3 percent (at the 95 percent confidence interval). Isolated speech impairments were found in 6.6 percent of boys, while 3.3 percent had speech and language impairment and 8.2 percent only demonstrated language impairment. (Total percent of boys affected was 18). For the girls, 6.7 percent showed speech only problems, 7.1 percent had speech and language problems, and 8.4 percent had only language problems (total: 22 percent). These figures demonstrate that 20 percent of all five-year-old children evidenced some form of speech and/or language impairment. However, it must be kept in mind that all speech and language impairments (including voice disorders and stuttering) were included in this prevalence estimate. Furthermore, estimates of specific developmental language disorder, which is not attributable to other concomitant developmental disabilities such as hearing loss, mental retardation, neurological impairments, dysarthria, autism, etc., cannot be derived, as these other developmental disabilities were unfortunately not differentiated or excluded in determining prevalence of language disorder in this study.

In conclusion, to date there are no studies employing appropriate methodology that address the issue of prevalence of specific developmental language disorders. This is an important area for study, but again will depend on the development of standardized, reliable inclusionary and exclusionary criteria for definition and diagnosis of specific developmental language delay.

#### IV. Causes (Etiology)

In reviewing causes of specific developmental language disorders, the two principal groups of factors that will be addressed fall under the broad heading of organic and psychogenic. These are variably referred to under other dichotomies, such as "nature" versus "nurture" or heredity versus environment.

Etiologies can be divided according to intrinsic factors, including such causes as sex-linked chromosomal aberrations, inborn errors of metabolism, the normal influence of gonadal hormones on prenatal brain development, as well as possible effects of excesses or deficiencies of such hormones during critical periods of development, and various neuroanatomical abnormalities that were genetically determined either directly or indirectly by biochemical abnormalities. Such factors could either be transmitted to a child through the genetic material of his parents (often as a homozygous allele) or would reflect a mutation sometime during embryogenesis.

The second class, the extrinsic factors, includes all possible insults to the developing brain during prenatal, perinatal, or postnatal periods. Such insults may result from trauma, seizure, dietary deficiencies (maternal or infant), infections, or exposure of the developing fetus to various teratogens such as heavy metals, drugs (including alcohol), and other environmental pollutants.

Finally, psychosocial factors such as a language learning environment in which the child is reared, mother-child interaction, and socio-economic status may have an effect on language development. Factors from each of these classes will be examined and reviewed in order to delineate the possible role each might play, in isolation or combination, in the etiology of developmental language disorders.

##### A. Genetic Factors

Only a few case reports of families with several members having language disorders can be found in the literature beginning in 1926 (McReady) continuing to the present time (Borges-Osorio and Salzano, 1985; Samples and Lane, 1985). Despite the dearth of case reports of families having language disorders, it is commonly believed that there may be a genetic basis for specific developmental language deficits (see Ludlow and Cooper, 1983, for review).

In the largest group study to date, Ingram (1959) obtained family histories on 75 probands. Eighteen probands had at least one parent with a history of speech or language difficulty (including delayed speech development, a history of stuttering, and "lispings"). Thirty of the 131 siblings of probands (23 percent) carried a diagnosis of severe language impairment, this being confirmed by

direct observation in 23. In the only other group study found in the literature, directly evaluating the potential genetic basis for specific developmental language disorders, Hier and Rosenberger (1980) found that 19 of 30 dysphasic children studied had a positive family history of developmental language disorder.

Unfortunately, these studies suffer from serious methodological problems, which include: a lack of objective diagnosis of specific developmental language disorders and exclusion of hearing impairment, autism, and mental retardation in the probands; parent and sibling diagnosis made by interview rather than by direct observation or testing; and no control group.

Many of these issues are being addressed in the San Diego Longitudinal Study Evaluating the Outcomes of Early Language Disorders (Tallal and Curtiss, 1980-1988). As part of this study, issues pertaining to incidence of family history as they relate to a possible genetic basis for specific developmental language disorders are being addressed in 100 LI children with specific developmental language delay and age, IQ and SES-matched controls. Based again on parent interview rather than direct observation or testing, the following preliminary family history data have been obtained from this population. Families of LI children report an average of 35 (plus or minus 3) percent of first degree relatives having a history of language and/or learning impairment, as compared to 20 (plus or minus 3) percent for controls ( $t = 2.91$ ;  $p < .005$ ). Next, probands were placed into one of three groups: 1) at least one parent impaired; 2) reported history of affected siblings or secondary relatives, but without positive parental history; and 3) no reported primary or secondary relatives with positive histories for language, reading, or writing impairments. When segregated in this fashion, results demonstrated that for the controls, 38 percent fell into Group 1, 26 percent into Group 2, and 36 percent into Group 3. For the LI children, 62 percent were in Group 1, 20 percent in Group 2, and only 18 percent in Group 3 ( $\chi^2 = 7.81$  [ $p < .02$ ]).

Obviously, the most convincing evidence for genetic influence in language disabilities would be the discovery of a chromosomal abnormality responsible for the defect. Because of the 2-3:1 male:female ratio, many investigators have concentrated on the sex chromosomes to address this possibility. Both of the two classical approaches in genetic research have been used in this attempt. In the first, several authors reported an increased frequency, as compared to the normal population, of sex chromosome abnormalities in children with delayed language acquisition (Garvey and Mutton, 1973; Mutton and Lea, 1980; Friedrich et al, 1982). Unfortunately, the results of these studies also suffer from lack of consistent definition and assessment of LI children and failure to rule out other diagnoses not specific to the language impairment.

The other approach is to prospectively follow children with sex chromosome abnormalities and watch for development of language difficulties. Although these studies also are replete with methodological problems, specifically, lack of operational definition of language disorders and subject selection criteria, some evidence in support of a hereditary component to specific developmental language disorders may be gleaned from these descriptive case studies. It appears that many children with sex chromosome anomalies have communication impairments, including low verbal IQ relative to performance IQ, and expres-



sive language deficits that persist into adulthood (See Ludlow and Cooper, 1983 for review). Eleven children with abnormal sex chromosomes were compared to 10 normal control children in a cytogenetic study reported by Leonard et al (1974). Blind evaluations at one and 2 1/2 years of age revealed no clinical abnormalities and no mental retardation among any of the children studied. However, language was considerably delayed in the children with abnormal sex chromosomes by the age of 2 1/2 years. Other studies evaluating language development in children with abnormal sex chromosomes can be summarized as follows:

1. 47 XYY boys: Radcliff (1982) reports verbal comprehension is not affected.
2. 47 XXY boys: Puck et al (1975) reported three of four males showed a lag in speech development; Neilsen and Sillesen (1976) reported an increase in frequency of speech difficulties. However, neither of these reports defines these speech and language difficulties nor reports any objective measures supporting their conclusions. Graham et al (1982) report the only well-controlled, detailed study of language, reading, and spelling abilities of XXY boys. This study compares a group of 14 unselected XXY boys ascertained during a neonatal screening survey with a matched group of 15 normal control boys. Studies demonstrated significant reductions in verbal IQ, expressive language functions, and reading and spelling abilities for the XXY group. The authors suggest that left-hemisphere-based difficulty in auditory processing may underlie some of these deficits. Further study demonstrated significant deficits in both non-verbal and verbal auditory processing abilities for the XXY group. On non-verbal tasks, the XXY group had more difficulty discriminating and sequencing at rapid rates of presentation. Of the 11 XXY boys with difficulty sequencing non-verbal tones at rapid rates of presentation, 2 had a primary auditory rate discrimination problem, while the remaining boys appeared to have auditory memory problems or difficulty sequencing at rapid rates of presentation, in the absence of auditory rate discrimination problems. The XXY group also had difficulty remembering and preserving the serial order of both speech and non-speech auditorily-presented materials. These difficulties were significantly correlated with problems in oral language production and in reading and spelling proficiency. These findings help to clarify previous misconceptions concerning the cognitive abilities of XXY boys and assist in clarifying the bases of the learning disabilities demonstrated by these children during their school years.
3. 47 XXX females. These XXX females have been reported to have receptive language problems (Pennington et al, 1980), as well as lower verbal IQ (Neilson et al, 1981). However, these authors emphasize that the language problems are difficult to evaluate because of general cognitive deficiencies that co-occur in these subjects.
4. 45 XO females. These females do not exhibit delays in early speech milestones in the only study reported (Robinson et al, 1979).

Occasionally, autosomal abnormalities have been associated with abnormalities

in language development on a case report basis. Examples include partial trisomy 15 (Moedjono et al, 1983) and 18-p (Thompson et al, 1986). The infrequencies of these reports indicate that at best gross chromosomal abnormalities represent only a small fraction of the language disabled population. However, the occurrence of even these sporadic cases indicates that, with the increasing ability of cytogenetic techniques to find even smaller chromosomal abnormalities, further research may elucidate regions of the genome associated with language disabilities.

Netley (1983) in his review of the subject, concluded that until such time as studies more clearly define, describe, and select for specific language disorders, no firm conclusions can be made pertaining to the genetic basis of specific developmental language disorders. It is clear from this scant literature review that language impairments per se have rarely been the focus of genetic research. Much more data needs to be generated before an informed conclusion pertaining to genetic basis of language disorders can be drawn.

#### B. Inborn Errors of Metabolism

Recognizable and unique behavioral phenotypes have been described for many genetically determined diseases, and it has been reported that inborn errors of metabolism may impair development and behavior in specific ways (Simopoulos, 1983). These inherited disorders tend to show a wide range of clinical severity, which may be a function of the degree of enzyme deficiency which exists in individual families. Although the incidence of metabolic disorders in the general population is considered to be very low (Nyhan, 1985), it may, in fact, be much higher within a population of children with more subtle cognitive deficits, such as language disorders. This hypothesis is presently being investigated as part of the new San Diego Center for Neurodevelopmental Studies recently jointly funded by NINCDS and NIMH (Tallal, 1985-1990).

In many cases, dietary manipulations after birth can overcome or bypass even severe enzymatic defects to the extent that no gross physical, cognitive, or behavioral disturbances appear to develop (Simopoulos, 1983). Unfortunately, such treatment may not entirely preclude the development of residual deficits, such as a language or learning disorders, as secondary biochemical and histological changes are well-established in utero for some inherited metabolic diseases.

There is considerable evidence that disorders of language development occur in children treated for various inborn errors of metabolism. Melnick et al (1981) investigated the linguistic development of 12 children from English-speaking, middle income families who were treated early in infancy for PKU. The researchers measured both receptive and expressive language, short-term auditory memory, hearing, oral-motor function, and articulation. Children were assessed longitudinally for approximately 18 months, beginning at 26 months. Results showed that they had normal IQ, normal development, normal hearing, and no oral musculature deviations. However, six of the 12 children (four male, two female) had retarded expressive language development, and four of these six had receptive language impairment, as well. In addition, all of these LI children were significantly below average on tests of short-term auditory

memory.

Similarly, Waisbren et al (1983) found that seven out of eight early treated children with galactosemia had substantial speech and language deficits. These children had normal growth, physical development, and mean full-scale IQ, although their mean verbal IQ was significantly lower than their mean performance IQ; a pattern commonly found among LI children. History of language delay was also reported for each child. Like the PKU children described earlier, these galactosemic children had particular problems with expressive language, and were found to score well below average on auditory short-term memory tests.

Speech defects and mental retardation are the most prominent clinical features of histidinemia, an inborn error of amino acid metabolism in which large amounts of histidine accumulate in body fluids because it is not properly metabolized to urocanic acid (Nyhan, 1972). The nature of the speech defect has not been documented; hearing is not impaired in histidinemic patients, and general mental retardation is only present in some. Again, similar to both PKU and galactosemic children, auditory short-term memory deficits also have been reported in these children (Nyhan, 1974). Treatment of established patients with low-histidine diet has not proven effective in improving their intellectual deficits, although it may help to normalize their growth if started in infancy (Nyhan, 1974). In one family case report, (Ghadimi et al, 1961) a three-year-old girl who had been diagnosed as having PKU was found to have extremely elevated histidine levels in both urine and plasma. Her emotional, social, motor, physical, and intellectual development appeared normal, but she spoke only single words. Other family members were subsequently tested and it was found that several also had elevated histidine levels. Witkop and Henry (1963) reported that of 10 known cases of histidemia, nine have shown defective speech. These researchers reported that although articulation was often impaired, the deficit appeared to be primarily one of language. Unfortunately, however, no tests were reported that directly differentiated verbal IQ from performance IQ, or receptive language skills from expressive ones. However, not all researchers agree that histidinemia is a primary cause of language disorders in children. Lott et al (1970) report that of four children with histidinemia, only one had an abnormal auditory memory span, and none had abnormal speech. Two of the children had developed normal language, and the other two were retarded. They found no evidence that language was impaired any more than other cognitive functions in the two retarded children, and concluded that the language deficits reported elsewhere in the literature were not caused directly by the metabolic disorder interfering with brain structures subserving language function, but rather may have resulted from hearing loss or general retardation.

There is some evidence that specific developmental language disabilities also may be behavioral sequelae of other genetically transmitted disorders such as Laurence-Moon-Biedl Syndrome and deLange Syndrome. Despite the fact that these syndromes are characterized by diverse impairments such as retardation and hearing loss, some researchers insist that these other deficits are not commensurate with the profound language disabilities that these patients experience (Garstecki et al, 1972; Moore, 1970). Garstecki et al (1972) reported that three children with the Laurence-Moon-Biedl Syndrome, who had normal

hearing, were below the 8th percentile for receptive vocabulary and had particular difficulty discriminating speech sounds. Nyhan and his colleagues have studied the behavior of several children with other inborn errors of metabolism: a patient with oculocutaneous tyrosinemia had normal intelligence with a specific learning disability (Ney et al, 1983); two patients with 3-methylglutaconic aciduria and three with ethylmalonic aciduria had isolated disorders of speech development, and no other clinical manifestations; and one patient with 4-hydroxybutyric aciduria, is currently being studied and has essentially no development of language (Nyhan, Personal Communication). Clearly, additional research is needed in this area to resolve discrepancies and to better assess neuropsychological and linguistic development in children with specific inborn errors of metabolism.

### C. Hormones

Especially before birth, when brain cells are developing rapidly, abnormal hormonal secretions can have permanent effects on brain structure and function and thus on behavior. Genetic defects can cause such abnormalities, but so can events that are environmental from the viewpoint of the fetus. Such events might include drugs taken by the mother during pregnancy (e.g., phenobarbital [Gray and Yaffe, 1983]) or a change in maternal hormone levels in response to severe stress (McEwen, 1983).

McEwen (1983) cautions that the effects of abnormal endocrine signals on prenatal brain development should not be underestimated. Timing is of the essence in the development of brain cells. If neurons are subjected to abnormal influences from hormonal agents secreted at the wrong time or in the wrong amounts, intricate neural circuitry may be disrupted. The effects of hormones on the immature, developing brain are generally greater and longer lasting than on the mature brain. Many of the long-lasting influences of hormones on the brain are deduced from experiments in which fetal or newborn rodents are subjected to excesses or deficiencies of key hormones during different periods, for example, thyroid and adrenocortical hormones. Imbalances cause serious, long-lasting, and fairly obvious effects on adult brain function.

Gonadal hormone influences are more subtle, and potentially could influence language development, particularly in boys, in at least three ways. First, prenatal androgens cause the right and left cerebral hemispheres to develop differently, such that the left hemisphere is late to mature (Chi et al, 1977); in fact, the size of the temporal plane of the left cerebral hemisphere does not catch up to that of the right until approximately 31 weeks gestation (McEwen, 1983). This delayed growth in the left hemisphere as a result of testosterone may account for the greater frequency of left-handedness in males; it also makes the male left hemisphere susceptible to insult for a protracted period of time. Since the left temporal lobe is considered crucial to normal human language development, and since this region in males will be far more vulnerable to a wide variety of late prenatal, perinatal, or early postnatal insults than will either the male right hemisphere or the entire female cortex, this provides a potential hypothesis as to why so many more boys than girls suffer from developmental language disorders.

A second way gonadal hormones might influence language development is that



there is a differential effect of androgen on the hemispheres. This too may cause the lateralization of brain structure and function to be more pronounced in human males than in human females (McEwen, 1983). For example, brain-injured females don't show such marked laterality on verbal or spatial tests as do brain-injured males; androgen-deficient males do less well than normal males on spatial tasks; and androgen-insensitive males do better on verbal than on nonverbal tests, unlike the normal male. This increased lateralization of function in males may increase the chances that congenital defects or brain damage will cause language deficits in boys, since the right hemisphere may be more highly specialized for extra-linguistic functions such as spatial skills in boys, and thus less able to take over language functions.

Finally, neurons that will occupy Wernicke's area in the left temporal lobe are formed before 20 weeks of gestation and migrate to their ultimate locations. Since 12 to 20 weeks of gestation is the period of maximum testosterone elevation in developing male fetuses, the hormone may affect some of these developing brain cells. It could influence their division or survival, migration, or the formation of stable connections with other neurons (McEwen, 1983). It is not known how a blood-borne substance that reaches both sides of the brain could have selective effects on one side. McEwen postulates that hormone-receptive cells may not be laid down in equal numbers on both sides of the developing brain, giving rise to an asymmetrical target for hormone action. It is equally plausible, however, that the effects are actually widespread, but simply appear to be selective because language, or some underlying perceptual prerequisites to language, are very fine tuned and thus are more likely to be disrupted by alternations in cerebral development that are induced by hormonal changes than are other behaviors or cognitive processes.

#### D. Teratogens

It is well known that numerous environmental contaminants can affect a developing fetus, for example, heavy metals, dioxin derivatives, polychlorinated diphenyl compounds, pesticides, tobacco smoke, alcohol, and others. A broad spectrum of sequelae has been associated with exposure to these various toxins, from abnormalities in the female or male germ cells, on up through development (Longo, 1980). Unfortunately, behavioral teratogenicity in humans is an elusive and poorly defined concept. To date much of the research on toxins known to damage the CNS (from both physiological and anatomical evidence), which result in behavioral disorganization in animals, has not been extrapolated to humans (McMahon, 1986). Even if it were, however, it would be difficult to explain human clinical findings on the basis of existing animal experimental models, since there are major differences between humans and other mammals, in their embryological development, their biochemistry, and in the structure and function of various brain regions (Scanlon, 1986). This caveat would, of course, apply especially to animal modeling of uniquely human cognitive abilities such as language. However, it is possible that higher mammals could be used in future research to model cognitive or perceptual prerequisite of language that are consistently disordered in language impaired children, such as nonverbal temporal perception or memory.

Neonatal deficits associated with intrauterine exposure to small doses of potential teratogenic agents vary considerably across individuals. For

example, of 242 newborns exposed prenatally to PCBs, some were born small and/or early, some had one or more of: labile states, motoric immaturity, increased startle response, or hypoactive reflex, and some had no detectable impairment (Jacobson et al, 1984). These sorts of between and within species differences make it difficult to pinpoint exactly which deficits are consistent sequelae of a particular teratogenic insult.

Some of the best research on the consequences of prenatal toxic insult has been in the area of lead poisoning (McMahan, 1986; Bellinger et al, 1985). One detailed investigation of the possible effects of lead on cognitive development, which included extensive language and auditory processing and memory assessment, was conducted by Needleman et al (1979). Baby teeth were collected from the children, and the dentine was analyzed for lead content. Children whose lead content was above the 90th percentile for the group were classified as "high," and those below the 10th percentile were classified as "low. The "high" children were found to have significantly lower scores than the "low" children on the verbal IQ, but not the performance IQ subscale of the WISC. "High" children were also significantly impaired on sentence repetition, on the Seashore test of auditory perception, on the Token test, on reaction time performance, and on most items of the teachers' behavioral checklist (although not on hyperactivity items). The researchers concluded that children with high lead levels were generally impaired with regard to verbal performance, auditory processing, and sustained attention.

It is clear that a great deal more research needs to be done in this area. With the exception of the Needleman et al study (1979), there appear to be no investigations of the effects of heavy metals on child development that focus on, or even address, language development specifically.

Not only does the placenta not protect the developing embryo and fetus from heavy metal toxins, most common drugs, including both alcohol and nicotine, cross the placenta readily, and circulation levels in fetal blood are often similar to those in maternal blood. Like heavy metal interactions, drug interactions may be important; it is not known whether the latter are additive or synergistic (Streissguth, 1986). In assessing possible relationships between intrauterine drug exposure and subsequent behavioral and developmental variables, it is also important to control for the many factors impinging on children postnatally, such as family characteristics, diet, schooling, SES, etc., that are potentially confounding or at least interactive variables.

One toxic substance that has been shown to affect fetal development at very low levels is alcohol. Dose-response curves are generally steep for developmental toxins, but the curve for alcohol exposure is nearly flat--demonstrating adverse fetal effects following only one to two ounces per day during pregnancy (Ob-Gyn News, July 1985). Streissguth (1986) reports that children of light drinkers (less than one drink per day on average) show attentional problems. Children of alcoholic mothers incur many disabilities, including retardation and impairments of learning, speech, attention, and fine and gross motor performance. Unfortunately, there have been no studies that have systematically looked at patterns of language per se in normal IQ children exposed prenatally to alcohol, nor have any studies indicated whether significant differences exist between performance and verbal IQ measures in

these children.

As part of the San Diego Longitudinal Study, (Tallal and Curtiss, 1980-1988) thorough medical questionnaires were completed by the biological parents of each subject. Prenatal, perinatal, and postnatal history, as well as demographic data, were collected. Of the numerous medical history and demographic variables assessed, only questions pertaining to prenatal exposure to teratogens (nicotine, alcohol, drugs) significantly differentiated the LI from the control group (Tallal et al, in preparation).

The effects of prenatal alcohol exposure, in either the first or third trimester of pregnancy, on subsequent neuropsychological and linguistic development is currently being studied as part of the new San Diego Center for Neurodevelopmental Studies (Tallal, 1985-1990). Neurological, neuropsychological, and linguistic development is being assessed in fine grained detail in children whose mothers either "binge drank" in their first trimester of pregnancy (before they realized they were pregnant) or were given large quantities of alcohol intravenously in their third trimester as a medical treatment for premature labor. The results of these new studies should help clarify the potential role of alcohol in developmental language and learning disorders.

It is known that both prenatal and postnatal administration of phenobarbital (PB) can have a detrimental effect on the biochemistry of the brain. It can also affect hormone levels and, consequently, sexual differentiation. Male rats exposed to PB during gestation showed a marked decrease in testicular synthesis of testosterone on the day of birth and the level of testosterone remained low throughout adult life (Gray and Yaffe, 1983). When PB is given in high enough doses, male brain development may be irreversibly altered (Clemens et al, 1979). Unfortunately, behavioral sequelae have not been well delineated for these animals. Nothing is known about the effects of prenatal exposure to PB on the acquisition of complex behavior such as language (Gray and Yaffe, 1983).

Other postnatally induced biochemical abnormalities may have specific effects on language development. Early reports of dietary chloride deficiency in infants documented biochemical abnormalities accompanied by delayed growth and developmental milestones. (See Kaleita et al, 1986, for review.) Kaleita et al (1986) report follow up studies of children with a history of ingesting chloride-deficient baby formula (neo-mull-soy/cho-free). Of ten consecutive cases studied, six children showed a consistent profile including language disability, motor incoordination, normal intelligence, and behavioral disturbance. Physical examination was normal.

## E. Infections

### 1. Prenatal Infections

Many infections are known to be capable of causing brain damage prenatally, including the cytomegaloviruses, rubella, herpes simplex, varicella, syphilis, tuberculosis, and toxoplasmosis (Sever). The brain damage may be seen in many forms, including mental retardation, seizures, cerebral palsy,

and learning disabilities. Usually, affected children are multiply handicapped; however, most studies have not been reported in sufficient detail (Sever).

The most promising research in this field to date has concentrated on evaluating outcomes of prenatal exposure to rubella virus. As early as 1970, Weinberger et al reported that rubella embryopathy may not be clinically evident at birth because of covert symptoms such as a delay in the expression of certain functions such as language. In addition, mothers may have no history of illness, even though they were exposed. Children with various disabilities such as speech, hearing, or visual disorders of any etiology were tested for the presence of the rubella HI antibody; the test was positive for five of 41 children born in 1964 (the year of the last rubella epidemic). These researchers concluded that although delayed speech was evident in the seropositive children, it was possibly secondary to general psychomotor retardation and/or deafness. The children tended to be small in early infancy and suffered from failure to thrive generally. In 1973, however, Pinsky et al reported that language delay is sometimes the only sequella of prenatal exposure to rubella virus. These researchers tested for the presence of rubella antibody in serum of 12 autistic children, 21 LI children, 25 psychiatric controls (non-language impaired), and 26 normal controls. Three of the autistic children and eight of the LI children tested positive, as did the mothers of these children, as compared with five of the 51 other (non-language impaired) children. Thus, there was a significantly higher incidence of seropositivity for rubella virus among LI children than there was among either of the control groups or among the general population. There was no historical evidence of maternal rubella in any of the children, and pure tone audiometry was normal for all.

## 2. Postnatal Infections

### Otitis Media

Otitis media (OM) literally means "inflammation of the middle ear." In this normally air-filled cavity, tiny ossicles transmit the vibrations of the eardrum (which forms the boundary of outer and middle ear) to the cochlea in the inner ear, which converts them into the nerve impulses the brain perceives as sound. The middle ear is normally open to the atmosphere via the Eustachian tube, which allows constant ventilation and maintenance of proper pressure. During the acute stage of inflammation, the middle ear may fill partially with fluid (effusion), usually because a blocked Eustachian tube does not allow drainage and ventilation. The result is termed "serous or secretory otitis media." If bacteria infect the effusion, the disease becomes "suppurative." The acute phase lasts about three weeks, and resolution normally can take up to three months (the subacute stage). Effusion lasting longer than three months, or fluctuating improvement, is called chronic (Bluestone, 1983).

The first report examining the effect of middle ear disease (otitis media) on children's language development appeared less than 20 years ago (Holm and Kunze, 1969). While a link was found between a history of the disease and impaired linguistic performance, Holm and Kunze (1969) emphasized that this was only a preliminary study. Numerous researchers in the following years also found a correlation between OM and impaired language in various populations,



leading some to claim a causal connection. Such reports sparked controversy, however, as none of the studies was able to completely eliminate the possible influence of other environmental factors. Recent reviews have criticized previous work for imprecise methodology and hence faulty conclusions. (See Kavanaugh, 1986, for a complete review of this subject.)

In his examination of the controversy, Leviton (1980) attempted to simplify the problem by proposing three direct hypotheses for investigation: first, that children with otitis media are at increased risk for hearing impairment; second, that hearing impairment increases the risk of language and/or learning disorders; and as a logical conclusion, that children with OM are at increased risk of language disorders.

The first hypothesis Leviton considers is that children with OM are at increased risk for hearing impairment. It is, of course, the dampening presence of fluid in the ear that is usually responsible for hearing loss, although other complications may also cause loss. Because of chronic effusion, the eardrum often perforates, which can cause up to a 30 dB conductive hearing loss. Alternatively, the mucous membrane in the cavity may become thick and fibrous, immobilizing the ossicles (Bluestone, 1983). One early study on OM followed 80 children for six months after treatment for the acute phase of an episode of OM, giving each subject five audiometric exams during that time. One-third had no hearing loss after the episode, 55 percent had loss that cleared within the observation period, and 12 percent had loss lasting the entire six months and beyond. Loss was defined as a requirement of 15 dB intensity for reception of a pure tone; normal subjects require an average of 0 dB (Olmstead et al, 1964). Kaplan et al (1973) tested 489 Alaskan Eskimos and found that 19 percent of those with a history of OM had hearing loss of 26 dB or more, compared with 9 percent of those without a history of the disease. Among those with OM, the number of episodes correlated strongly with loss (7 episodes, compared to 3.4 episodes for those who heard normally.) Unfortunately, it is unspecified whether children currently suffering an OM episode were included in the hearing testing. These results are significant, as they bear on the second hypothesis that hearing impairment can lead to language and learning problems.

Audiologists label as "mild" the average 25 dB loss accompanying OM, but investigators have found that the threshold for auditory handicap is age-dependent (Kirkwood and Kirkwood, 1983). It has been suggested that while adults can "fill in" lost input using their well-established grammar and knowledge of how the world operates, children are continuing to form and internalize linguistic rules on the basis of their auditory experience. Therefore, mild hearing loss will be comparatively more damaging to them. As Mustain (1979) points out, the normal ear requires 40 db intensity to discriminate 90 percent of a group of monosyllabic words. A child with 25 db loss would then require 65 db to achieve the same level of discrimination, and normal speech rarely exceeds 50 db. Menyuk insightfully notes that the fluctuating nature of the loss caused by OM may make it even more damaging. The child receives inconsistent stimuli as hearing improves and deteriorates with the episodes of the disease, and so may find it even more difficult to develop effective listening strategies than a child with consistent mild loss (Menyuk, 1980). It follows logically that if OM causes hearing loss and hearing loss

leads to learning/language disability, then OM increases the risk of language disorders. Evidence for the first two hypotheses is not especially controversial, yet studies that set out to consider specifically the third hypothesis have not convincingly proven a causal relationship. The relationship between otitis media, auditory processing, speech processing, and language disorders was the focus of a recent conference sponsored by the NICHD. A complete, updated review of this topic recently has been published as the proceedings from this conference (Kavanaugh, 1986).

Holm and Kunze (1969) administered a battery of speech and language tests to children with a history of OM and to controls. The OM group performed significantly worse on all tests that required the receiving or processing of auditory stimulation or the production of a verbal response. Responses on purely visual or motor tasks or those which allowed yes/no answers did not differ significantly. In addition, the difference in parent rating of abilities reached the .01 level of confidence, in the expected direction. The authors stress that socioeconomic matching was the only control for important factors such as intelligence, motivation, and language stimulation in the home. They suggest that it may well be that the same parent who disregards the child's OM until it becomes chronic also provides less language stimulation. Holm and Kunze's results have been replicated in several studies that have attempted to better control for potentially confounding environmental and demographic variables (Kaplan et al, 1973; Lewis, 1976; Sale and Ruben, 1981; Brandes and Eringer, 1981; Zinkers et al, 1978). Gottlieb et al (1979) approached the issue from the opposite angle, by comparing learning disabled children with significant central auditory processing deficits (Group A) with learning disabled children with no evidence of auditory perceptual disturbances (Group B). Groups were further divided according to history of OM. Forty-six percent of Group A had a history of the disease, a significantly higher prevalence than was found in Group B (22 percent). Similarly, 41 percent of Group A were delayed in language development compared to 18 percent of Group B. The authors concluded that the higher rate of OM in Group A as compared to Group B indicated that middle ear disease in early life may be an important factor in the development of auditory processing deficits, which, in turn, may compromise development of language and other cognitive functions. A similar theory has been investigated by Eimas and Clarkson (1986).

More recently, prospective studies on infants have helped provide knowledge on hearing impairment and language development during the earliest episodes of OM. Such work will help to answer the frequent criticism that the retrospective design studies cannot provide a causal link since they lack information on early hearing levels. Thelin et al (1979) administered a behavioral hearing threshold test for speech and a receptive-expressive emergent language scale to 143 infants at one year of age. The language quotient correlated significantly ( $p < .01$ ) with the speech detection threshold, so that poorer hearing led to poorer language skills. Significant articulation and expressive language delays in 47 children between two and five with confirmed history of at least three OM episodes has also been reported (Lehmann et al, 1979).

Friel-Patti et al (1982) used auditory brainstem response technology as an objective electrophysiological measure of hearing in 35 infants. Two other independent measures confirmed any hearing impairment or middle ear pathology at

six, 12 and 18 months. The REEL, parent interview, and observation of the child determined the infants' typical language performance at 12, 18, and 24 months. At study's end, three groups were formed on the basis of number of OM episodes: Group 1 had one or less; Group 2 had three or more episodes and half had ventilation tubes by 18 months; Group 3 had two episodes. Seventy-eight percent of Group 1 and 85 percent of Group 3 showed no language delay. In contrast, 71.5 percent of Group 2 (the otitis group) showed some delay with 43 percent demonstrating more than six months' delay. Nine of these patients had bilateral hearing loss of 25 db or more and four had abnormal brainstem readings. This is a clear indication that repeated episodes of OM can lead to language delay, either because of hearing loss, or because the feeling of ill-health reduces the infant's attentiveness to stimuli. These results have also been replicated in numerous studies using different methodologies and designs (Silva et al, 1980; Schlieper et al, 1986; Eimas and Clarkson, 1986; Fleagans, 1985).

In a large longitudinal study reported by Menyuk (1980) 250 children were followed from birth to age seven years. Assessment at seven years indicated continued impact of OM on speech and language development, specifically on expressive language. Four or more episodes appeared to be the critical number affecting long-term impact.

Zinkus (1986) in a review of the types of language, memory, and perceptual difficulties frequently seen in children with OM points out that many children with OM develop completely normally. Thus, OM does not directly predict developmental language deficits. He concludes that some children may already be at risk for developmental language disorders, and the presence of OM interacts with other causes to lead to their expression.

As part of the San Diego Longitudinal Study of the Outcomes of Early Language Disorder (Tallal and Curtiss, 1980-1988) the question of the relationship between OM and pattern and severity of language disorder is being investigated from a different vantage point. The question raised in this study is not whether OM causes language disorder, but rather whether the pattern or course of language disorder is significantly different in developmentally language impaired children with or without a history of chronic OM. Within the well-defined and selected population of 100 LI and 60 normal children participating in this longitudinal study, 15 LI and 9 normal children had a history of five or more treated cases of OM. Perhaps surprisingly, results of extensive fine-grained analysis have revealed no significant differences in the degree or pattern of neurological, neuropsychological, intellectual, speech, language, or social/emotional development as a factor of OM either within the LI or normal group. Thus, although previous research has indicated a relationship between OM and LI, the results of this study clearly demonstrate that if OM causes language disorders, the resultant pattern of those disorders is indistinguishable from those caused by other factors (i.e., genetic, neurological, teratogenic, etc.). Although there were numerous significant differences found between the LI and normal children participating in this longitudinal study, these differences cannot be attributed directly to history of OM, as no within-group differences emerged for either normal or LI children as a function of OM. (Tallal et al, in preparation).



## F. Brain Damage

Evidence appears to be mixed on whether early brain damage selectively causes language disorders (Hier and Rosenberger, 1980). On the one hand, Garoutte (1967) argued that prenatal cerebral injuries, severe enough to produce a delay in language acquisition, are generally accompanied by significant mental retardation. In addition, LaBenz and LaBenz (1980) point out that no significant pre- or perinatal history of frank neurological insult was found in LI children in the extensive National Collaborative Perinatal Project. On the other hand, Benton (1964) reported that there was considerable evidence implicating early CNS damage as a causative factor in dysphasia, including: 1) medical histories of cerebral complications such as anoxia, head injury, meningitis, encephalitis, and maternal rubella; 2) increased incidence of neurological "soft signs," such as clumsiness; and 3) higher than normal number of EEG abnormalities. Eisenson (1969) found that 36 of 73 dysphasic children had positive EEG findings; 22 of these had localized abnormalities, of which 19 were in the left hemisphere. Furthermore, 64 percent of 87 LI children had temporal horn abnormalities demonstrated by pneumoencephalography (Rapin and Wilson, 1978). Among 30 children with a delay in language acquisition, computerized brain tomography revealed focal left temporal lesions in two. In a recent study of auditory processing disorders in children with language/learning disabilities, Mesiek et al (1985) reported that 2 to 3 percent of children referred for central auditory disorders were found to have active neurological problems. These included finding 1) a large subarachnoid cyst with no midlatency evoked potential response in one child (although brain stem response was normal); and 2) previously undetected disorders, including severe left ear deficits on dichotic listening tasks, and bilateral deficits on other central auditory processing tests that were strikingly similar to profiles reported for patients who have undergone surgical commissurotomy (split brain).

What type of damage would have to be sustained developmentally in order to produce a selective language disorder, uncontaminated by other cognitive disabilities? The animal literature reveals that large, prenatally induced lesions resulting in substantial cortical loss and displacement did not affect the development of learning behaviors, although much smaller lesions in the same regions in adult animals have had significant effects (Goldman, 1978). Anatomical studies performed on prenatally lesioned animals, after puberty, indicated that organizational differences in cortical development had taken place, although learning was not impaired and no behavioral deficits were found. Goldman concludes that pre- or postnatal lesions are probably not responsible for marked and long-standing impairments in language development. However, she believes there may be a lack of, or disordered development of, particular language related brain regions in dysphasic children. She looks to intrinsic rather than extrinsic factors to explain the phenomenon.

Galaburda and Kemper (1979) agree with this suggestion that intrinsic focal disorders of cortical development may underlie some cases of specific language and reading disorders. At autopsy, the brain of an adult with a life-long history of language and reading disorders showed signs of neuroanatomical abnormalities, all confined to the left hemisphere. There was no evidence of neuron loss or gliosis. However, there was a striking area of polymicrogyria,



with adjacent molecular layers of the abnormal gyri fused; no normal cortical lamination; and no cell-free layer. These abnormalities were confined to the posterior parts of Heschl's gyrus and to the left planum temporale, an area corresponding roughly to the auditory association region known as Wernicke's area. The remaining auditory fields were relatively unaffected. The cause of this type of malformation is unknown, but in six of the 16 autopsy cases of language/learning disorders that have been reported, family history suggested a genetic component. In seven of these 16 cases, the polymicrogyria anomaly was restricted to a small, focal area. Galaburda and Kemper (1979) speculate that a familial form of localized polymicrogyria may be responsible for the language impairments of these patients.

Only one child with a specific developmental language disorder has ever come to autopsy (Goldstein et al, 1958). This child had normal hearing, a performance IQ of 97, and a verbal IQ of 76. By nine years of age, he had acquired some expressive language, but still had considerable difficulty processing speech when it was spoken at a normal rate. His comprehension was reported to be improved when spoken to slowly. At autopsy, old, bilateral infarctions of the Sylvian regions and severe retrograde degeneration of both medial geniculate nuclei were found.

Geschwind (1978) notes that even if there is a lack of visible anatomical change or identifiable biochemical lesion, there may still be a neurological basis for developmental dysphasia. He suggests that since there is a considerable anatomical variation in the normal population, certain brain regions will be developed to a lesser or a greater degree than will others in a given individual, and hence, people will vary in the degree to which they will be able to acquire certain skills.

He cites as evidence for this hypothesis that the planum temporale, a brain region which corresponds roughly both to Brodmann's area 22 and to Wernicke's area, is asymmetrical in the "average" human, tending to be approximately one-third larger on the left side than on the right (Geschwind and Levitsky, 1968). This pattern of asymmetry has also been seen in human fetuses and neonates (Geschwind, 1978). However, there is a great deal of variation in this ratio among the human population; one man with a high verbal IQ was found to have a planum temporale that was seven times as large on the left side as on the right, while dyslexics at autopsy have been found to have nearly symmetrical patterns (Geschwind, 1978; Galaburda and Kemper, 1979).

Geschwind (1978) reported that of 24 patients with a history of developmental dyslexia, ten had a reversal of the normal asymmetry pattern, such that the right parieto-occipital region was wider than the left. These "reversed" dyslexics were significantly more likely to have had delayed onset of language as young children than were the other dyslexics not showing this reversal, and they also had a lower verbal IQ, but not a lower performance IQ, than did the other dyslexics. Since this pattern of reversal occurs in 10 to 12 percent of the population, whereas dyslexia occurs in only 1 to 3 percent of the population, Geschwind speculates that this pattern may predispose a child to develop dysphasia and dyslexia, if other predisposing factors are also present (such as intrauterine insult, for example). On the basis of these findings, Geschwind postulates that if a child is endowed with a left planum temporale

that is unusually small (a reversal of the normal asymmetrical anatomical pattern) problems in acquiring language might result, either because language will be lateralized to a hemisphere less suited to support language function (the right hemisphere) or because abnormal interhemispheric interaction is set up because the left hemisphere cannot subordinate the right as it normally would. In support of this hypothesis are the findings of Eisenson (1966) who found LI children developed manual laterality (handedness) very late as compared to normal children and that there is a higher than normal incidence of left handedness among these children. Similarly, Arnold and Schwartz (1983) found that of eight LI children, six were right lateralized on a dichotic listening task for language material, as compared to only one of eight autistic children. None of the eight normal children tested showed right lateralization.

While the data supporting Geschwind's hypothesis are striking, they are equally capable of supporting other theories, such as the possibility that genetic anomalies (or even the presence of extrinsic, traumatic factors) and not normal genetic variation, underlie the development of a left temporal lobe that is inappropriately sized, or inappropriately lateralized to support normal language function.

It would appear that the left hemisphere, for whatever reason, is the hemisphere most suited to subserve language function. Anatomical evidence suggests that the two hemispheres do not have equal potential early in development. Witelson and Pallie (1973) observed that the left hemisphere is greater in size than the right in neonate humans, while Chi et al (1977) found that the left auditory association cortex is larger than the right in fetuses by the third trimester. Right/left asymmetry in EEG responses to speech stimuli have been found in infants as young as six months (Ludlow, 1978). Thus, normal language lateralization appears to be not so much a struggle for dominance between the two hemispheres as an outcome of very early development of structures or mechanisms that will mediate language in the left hemisphere.

By adulthood, 95 percent of people are left hemisphere dominant for language (Geschwind, 1978). The right hemisphere is generally severely limited in language use; studies using split brain patients indicate that it can recognize and understand a large lexicon, mostly of concrete words such as nouns and verbs. However, if such patients are forced to rely on right hemisphere function, they cannot learn meaningless nonsense words, their short-term memory is severely restricted, and speech production is virtually impossible (Zaidel, 1978). Interestingly, the pattern of language, as well as auditory perceptual performance of split brain patients using the right hemisphere is strikingly similar to that of children with acquired aphasia (Zaidel, 1978) and children treated early for galactosemia (Waisbren et al, 1983) and children with developmental language/learning disabilities with concomitant central auditory processing disorders (Musick et al, 1985). Similarly, Zaidel (1978) reported that the disconnected right hemisphere, but not the disconnected left hemisphere, is significantly impaired in responding to rapidly presented acoustic information, showing comparable deficits to those reported by Tallal and colleagues for language impaired patients (Tallal and Piercy, 1973, 1976; Tallal et al, 1985; Tallal and Newcombe, 1978).

Consistent with these data, Tallal and Newcombe (1978) showed that adults with focal lesions of the left hemisphere (aphasia) but not the right hemisphere are also impaired in discriminating rapidly presented nonverbal acoustic stimuli, as well as speech contrasts characterized by rapidly changing acoustic spectra. Furthermore, the degree of impairment shown in adult aphasics with left hemisphere lesions on rapid auditory processing tasks correlated highly ( $r = .83$ ) with the degree of their receptive language impairments. This is precisely the same pattern of deficits reported for children with developmental language impairment (Tallal et al, 1985).

#### G. Psychogenic Effects

Language is a highly social activity, and language development normally proceeds within the context of a child's social environment. Caregiver-infant interactions determine which language the child will learn and which lexical items and syntactical forms he will first utilize. Children raised in extremely impoverished environments fail to develop language at all (Curtiss, 1977). Therefore, developmental psychologists have often hypothesized that language impairment is related to, or may be caused by, an impoverished social environment (often assumed to be synonymous with low socioeconomic status).

There are two separate issues that must be addressed. First, whether or not evidence supports a contention that the type or complexity of language developed by non-dysphasic (normally developing) children is in any way related to the social environment of dysphasic children (children who are not simply at the lower end of the a language continuum, but who represent a population with disordered development) differs significantly from that of non-dysphasic children.

With regard to the first issue, Tizard (1983) studied various usages of language, (e.g., to categorize, abstract, infer logical relationships, request or give information) and found significant social class differences in the frequency of usage, but not in the type of usage. Another study (Fein, 1981) yielded very similar results from an investigation of the sociodramatic play of 45 middle and lower class children. This study found that although middle class subjects verbalized more frequently, the quality of the language used by the two groups did not differ.

A 10-year longitudinal study investigating the linguistic development of 128 British children (Wells, 1983) found that a significant relationship was observed between achievement and SES only after subjects entered school. This implied that lower SES children do not adapt as well or gain as much from the school experience as do children from higher SES environments. In addition, it is now well known that lower SES children suffer from lack of exposure to the standardized procedures used in measuring IQ (and various components thereof, including language development) (Sandeep, 1981). Either withdrawal from an alien social situation or poor scores on standardized language measures could easily be misinterpreted by the school as evidence of verbal deficits. This misinterpretation may have yielded artificial data pertaining to SES and language development.

To conclude, current evidence strongly favors the view that the home environ-

ments in low SES families provide adequate verbal stimulation for normally developing children. In addition, children of such families display normal verbal cognitive skills that are not significantly different from those of children from higher SES families (Tizard, 1983).

With regard to the second issue, it is unfortunate that very few studies of dysphasic children have attempted to control for factors such as SES. Matching LI and control children on the basis not only of "child" variables such as age, IQ, sex, handedness, and so on, but also on the basis of "parent" variables such as parents' educational attainment and family SES, would appear to be the simplest way of ensuring that social factors cannot confound results. Tallal and Curtiss have done this in the San Diego Longitudinal Study (1980-1988) and thus can rule out SES factors as contributing to any group differences found in their investigations.

#### H. Conclusions and Future Research Considerations

Developmental language impairment, with concomitant temporal auditory processing and memory deficits appears to be consistent with a pattern of innate or progressive dysfunction of the left temporal association cortex. This may be due to the presence of a functional deficit within the left hemisphere, to an abnormal state of cerebral asymmetry, or to disordered interhemispheric integration. The mechanisms by which this neurological dysfunction occurs is still unresolved. It is likely that an interaction among factors may be responsible (Ludlow and Cooper, 1983). For example, LI children may be predisposed to their condition by having inherited a left temporal lobe that is on the lower end of the continuum of normalcy, as Kinsbourne (1978) suggests. Conversely, a variety of intrinsic or extrinsic factors may be responsible for an initial induction of a neurological abnormality by causing abnormal cell migration in the brain, by interfering with neurogenesis in regions of the brain where neurons continue to proliferate after birth, by interfering with the normal subtractive neural processes of neuronal death and axon retraction, or by otherwise disturbing the normal development of myelination (Musick et al, 1983) or of the systems and structures subserving language (Ludlow and Cooper, 1983; Broman, 1983; Janowsky and Finlay, 1986). However, it is possible that not all children will be similarly impacted by such disturbances. Certain children may be subject to other intrinsic or extrinsic factors (for example, otitis media) which may interact with the original factors to exacerbate (or perhaps even to compensate for) the original neurological abnormality.

It is important to remember, also, that not only do anatomical asymmetries occur in the two hemispheres, but brain development itself is asymmetric. Homologous cortical regions do not develop simultaneously on the two sides. Therefore, factors which affect the brain at a specific point in fetal life may selectively impair the development of specific cortical regions on one side while leaving the other intact (Kinsbourne, 1978). Thus, the timing of neural insult may be crucial in determining which structures are most affected and, as a result, whether language development, as opposed to other types of development, will be affected.



There is a tremendous need for anatomical studies of the normally developing brain at different stages of development, especially with regard to cytoarchitectonic studies of the organization and timing of development of each area. The study of the brains of dysphasic children who meet with accidental death would also be immensely important.

With regard to the effects of prenatal exposure to teratogens on the developing brain, new procedures need to be developed to: 1) determine how to monitor the presence and distribution of metagenic and teratogenic agents; 2) determine what the important threshold levels are; and 3) determine their effects on fetal and infant brain development (Longo, 1980). There is a pressing need for cross-drug comparisons, cross-species comparisons, and improved behavioral and cognitive testing (Gray and Yaffe, 1983). Major limitations of such studies so far have included inadequate control of other confounding variables (besides the presence of the teratogen in the prenatal environment), uncertain accuracy of maternal drug histories; and outcome criteria that provide insufficient delineation of subtle developmental delays (Gal and Sharpless, 1984).

There is also a growing need for more longitudinal studies of normal and abnormal development. It is very difficult to answer the most pressing questions about developmental disorders based on studies that cannot assess development over time. In addition, it is increasingly important for future research to gather multidimensional, multidisciplinary data from the same child: behavioral, neurophysiological, anatomical, and biochemical, as well as complete medical, social, and genetic family histories.

#### V. Treatment

Before embarking on a discussion of the types of interventions that have been developed specifically for language disorders, it is helpful to point out that what constitutes intervention for specific disorders varies widely within the profession of speech-language pathology. This variation, for example, is responsible for the controversy that exists regarding what is or what should be treatment for the associated characteristics, such as auditory processing and memory disorders, that characterize specific language impairment. Differences in opinion exist regarding the goals of intervention, the form it should take, its content, and the methods to use for evaluating its effectiveness. Some of these differences derive from divergent theoretical positions, for example, those regarding the relationship between auditory processing disorders and language disorders. Johnston (1983) points out that, in any survey of language intervention programs, diversity is to be expected because intervention is an extension of a particular theoretical perspective. Johnston challenges professionals engaged in developing intervention programs to take theory based on recent research results seriously and to examine and evaluate the assumptions implicit in intervention practices with reference to that theory.

Controversies in intervention may arise from differences in how speech-language pathologists define their role and responsibility in relation to the management of auditory processing, speech, language, and learning disorders. Often this reflects a professional's educational background and clinical training experience as well as personal bias. Professional associations also

contribute to these decisions by defining and restricting areas of responsibility and professional roles. However, these defined roles may be difficult to modify in step with research advances and, as such, may impede therapeutic advances. Similarly, narrow professional boundaries may fail to recognize the multifaceted nature of complex developmental functions such as language. Unfortunately, it is the child, who becomes fractionated for the purpose of treatment among professionals sticking adamantly to their prescribed roles, who is potentially the big loser.

#### A. Language Intervention Research

Leonard (1981) reviewed the literature on training studies that attempted to facilitate LI children's production of language. He examined those studies providing evidence that the reported language gains were attributable to training, and not to other factors. Leonard utilized an "outcome" orientation to organize the literature. In evaluating intervention research, he examined whether a particular procedure was effective in teaching a new behavior, and to what extent the procedure had generalizable effects. Effectiveness studies examine the amount and degree a language behavior changes as a result of a treatment procedure. In contrast, studies of treatment effects examine the products of the intervention: what related language behaviors change and under what conditions. Leonard reported that numerous procedures were successful in teaching linguistic behavior to impaired children. He concluded that in general language intervention appeared effective in increasing impaired children's rate of language acquisition. However, variability existed in the amount of success children exhibited. Specifically, children varied in the rate and ease with which they proceeded through the treatments and in their ability to generalize learning to other settings, people, and behaviors. This variability has been assumed to be related to the specific linguistic behaviors that were taught, the duration of the training, the characteristics of the children being taught, and the measurements utilized.

Leonard's (1981) excellent work has provided a foundation for the current review and an opportunity to follow the direction of language intervention research for more than a decade. The discussion that follows will focus primarily on research studies published since 1981. The dearth of studies reviewed reflects the paucity of research on intervention. This is a surprising and disconcerting finding, in light of the amount of time clinicians spend in providing intervention.

Intervention research seemed to address one of three broad categories of inquiry: studies investigating effectiveness of procedures, effects of procedures, and the language acquisition process as applied to LI children. Effectiveness studies included a variety of issues.

##### 1. Treatment Effectiveness

During the 1970s, the most commonly employed intervention procedures were based on operant conditioning principles. The clinician tightly controlled the antecedent and subsequent events in the treatment paradigm and provided mass trial training. Often the remedial context was a therapy room with minimal materials and equipment. A major thrust in the last five years has been to

reduce the amount of structure in treatment and to utilize more naturalistic contexts to teach language behaviors to impaired children. Several studies explored the effectiveness of procedures utilizing naturally occurring interactions between children and adults. One such treatment, "incidental teaching," demonstrated effectiveness in increasing preschool children's amount of verbalization and overall language complexity (Warren et al, 1984). The effectiveness of incidental teaching in facilitating language development has been well documented. (See Warren and Kaiser, 1986, for a review of this procedure.) Schwartz et al (1985) demonstrated the effectiveness of adult-child discourse as a technique for teaching successive single word and multi-word combinations. Discourse offers a natural interaction between speakers, but allows the opportunity for the adult to model linguistic forms and to guide the child's responses. Olswang et al (1982) also demonstrated the importance of utilizing naturally occurring interactions between adults and children to create a teaching paradigm. In this study, a LI child's functional requesting of objects and actions increased following treatment implemented by the speech/language pathologist and the classroom teacher. The teacher was taught to recognize "request opportunities and to naturally elicit responses from the child, which, in turn, resulted in increased spontaneous requesting throughout the day and across classroom activities. Treatment using conversational interactions versus the traditional, structured, mass-trial training approach, shows a change in the focus of intervention. These findings reflect the success of two philosophically different approaches in increasing children's linguistic, communicative performance.

Three studies compared the relative effectiveness of the naturalistic, interactive treatment procedures to structured approaches. Cole and Dale (1986) and Friedman and Friedman (1980) utilized group designs and found no difference in the linguistic performance between two groups of children receiving the two different treatments. However, Friedman and Friedman (1980) observed a treatment by aptitude interaction, whereby children with lower IQs performed better in the structured condition, and children with higher IQs performed better in the interactive condition. This finding was not replicated by Cole and Dale (1986). The conflicting results regarding aptitude by intervention interaction may have been due to different subject characteristics, with cognitive abilities being lower in the Cole and Dale study, and to different criteria for defining subjects as being LI. Olswang and Coggins (1984) compared three different interactive teaching procedures, each differing in the amount of structure imposed upon the context and the child. No differences were found between the techniques in teaching children multi-word combinations.

One reason relatively few differences may have emerged regarding the relationship between child characteristics and the effectiveness of different treatment procedures may be the use of group research designs, where individual variation in performance is collapsed into group data. Group designs have contributed important information to the literature regarding overall treatment effectiveness. However, the value of such studies lies in their ability to address the broad question of which treatments work, not which treatment works best with which children in teaching different linguistic structures. Time series, or single subject, research designs may allow for the investigation of the learning process, to determine what techniques are most effective with which children. For example, Olswang et al (1983) examined the lexical learn-



ing of four preschool LI children using different stimulus materials. Each child was taught lexical items through picture identification and object manipulation. The authors hypothesized superior learning in the object manipulation condition because all children were in Piaget's sensorimotor Stage V or VI of cognitive development. However, results showed that two of the children learned more words, more rapidly, in the object manipulation condition; one child learned more words in the picture condition; the fourth child showed no preference. The authors interpreted the variation in performance as a reflection of differences between children in language learning processes and "readiness" for learning.

One general criticism of treatment effectiveness research has been a failure to control for maturation. Documenting treatment effectiveness with LI children must demonstrate convincingly that treatment is more effective in changing behavior than maturation alone. Further research is needed to explore the relationship between the success of different treatments and child characteristics, such as IQ, language level, language profile, learning style, and the specific linguistic structures being learned. Looking for a "single, best procedure" for treating all LI children is probably naive, and not supported by intervention research to date.

## 2. Treatment Effects

Research investigating treatment effects has focused on what behaviors change and under what conditions. Treatments are designed primarily to increase the occurrence of a particular, target behavior. Learning is judged by the products of the treatment, by the generalized results of the training effort. The ultimate goal of treatment is more effective communicative competence (Rice, 1986). How much training is needed to accomplish this has been a research focus for at least the last decade. Numerous studies have addressed this issue by examining response and stimulus generalizations. While these terms have some degree of overlap, they can be viewed separately. Response generalization refers to changes in behavior which are similar to, but not the same as, target behaviors. Response generalization can be conceptualized as finding that the conditioning of one response has influenced the occurrence of a different although related response (Hughes, 1985). Stimulus generalization refers to the use of the target behavior in different contexts, or under different stimulus conditions than which it was taught, including different persons, settings, time, etc. Researching treatment effects has involved studies in which narrowly defined target behaviors have been treated while the occurrence of related behaviors (response generalization) and the target behaviors in other contexts (stimulus generalization) have been monitored.

Two main issues concerning response generalization are: 1) what constitutes a response class; and 2) the number of exemplars needed to trigger generalization. Hegde (1980), Hegde and Gierut (1979), and Hegde et al (1979) have examined response classes by systematically exploring generalization of syntactic structures. Hegde et al (1979) found that in treating the auxiliary verb ("She's running"), generalization occurred to the copula form ("She's a doctor"), but not to the uncontracted auxiliary ("He is swimming"). Hegde's works have identified a response class of "is" verbs, although the parameters of the class remain unclear.



Other studies have illustrated that at least with some LI children, only a few exemplars of the target behavior needed to be directly taught prior to the occurrence of response generalization. In a language comprehension study, Bunce et al (1985) trained two LI preschoolers in a limited number of preposition + objective exemplars. Generalization to both comprehension and production of untrained words was observed. Connell (1986) also observed response generalization occurring after a limited number of items illustrating the entity + action semantic relation had been taught. These studies suggest linguistic "rule learning" can be taught and that teaching can often be efficiently accomplished by exposing LI children to a limited number of training items.

Studying stimulus generalization, Warren and Kaiser (1986) trained preschool LI children to produce a variety of linguistic structures. Monitoring the children's language in a free play situation revealed 74 percent of the structures generalized to the nontraining setting, indicating the success of treatment. A study by Culatta and Horn (1982) systematically examined the generalization process by monitoring LI children's spontaneous production of target syntactic structures in a parallel play situation with the clinician. They reported stimulus generalization occurring early in the treatment. They accounted for this success by the nature of the training procedures which appeared to naturally evoke the production of the target behavior. Culatta and Horn (1982) and Connell (1982) suggested that rule learning, i.e., naturally occurring generalization, can be fostered if treatment programs not only emphasize the components of linguistic rules, but also teach children how to use these rules.

Research concerning stimulus generalization again raises the issue of treatment efficiency. Some studies have documented the occurrence of spontaneous generalization of newly learned behaviors to other settings and people without direct treatment generalization training (Warren and Kaiser, 1986; Olswang et al, 1986). Other studies, like Culatta and Horn (1982), suggested the treatment conditions were directly related to the successful generalization of the learned behaviors. In all of these studies the entire treatment package resulted in generalization. These treatments, though different, were successful in teaching LI children a generative behavior. No research to date has isolated the components of treatment packages that contribute to, or are responsible for, generalized learning. Such information will contribute to our knowledge concerning the generalization process and to the design of the most effective, efficient training programs.

Measuring stimulus generalization is one way of assessing whether learning is occurring. If a child can only use a structure in the teaching paradigm, one might ask if he/she has indeed learned the structure. In a study by Donahue (1984), learning disabled children participated in a program designed to increase their requests for clarification of ambiguous messages, and thus to increase their conversational competence. While the children improved in their production of verbal queries in a structured, 20-question task, they did not perform as competently in a referential communication task. Donahue raised the point that the tasks were not similar enough for transfer of skills to occur. Dollaghan and Kaston (1986) taught school-aged children to identify inadequate

messages and how to use verbal queries to react to such situations. Skills were taught through a combination of direct instruction, modeling, role-playing, and guided discussions. The data showed clear gains in the appropriate use of verbal queries. The conflicting results obtained by the Donahue (1984) and Dollaghan and Kaston (1986) studies raise several questions: Does lack of stimulus generalization reflect a flaw in treatment in teaching rule learning? What is the influence of context on performance? If a client can only produce a behavior in a limited context, what does that mean? What behaviors should we measure to assess generative language behavior?

Research investigating response generalization needs to be continued to explore the parameters of response classes. Research needs to define the extent to which syntactic, semantic, and pragmatic behaviors are co-related, and thus will co-vary in treatment, and which will not. Further, research needs to explore the number of training exemplars necessary to achieve a generative, productive response from an impaired child and which type of exemplars better facilitate learning, i.e., prototypic or moderately discrepant exemplars. To monitor learning, both response and stimulus generalization need to be addressed. The clinician is faced with the task of determining whether a child has learned a generative, productive behavior. Measuring a variety of behaviors in a variety of settings is essential, but must also be practical. Further research is needed to determine the influence of different tasks on measuring performance and learning. Finally, additional data are needed to define the components of treatment that best facilitate generalization.

### 3. Language Acquisition Process

The third area that intervention research has addressed is the acquisition process. Studies investigated which aspects of the normal language acquisition process apply to impaired children in their learning of language during treatment. Recent research with normally developing children has documented that the acquisition of lexical items proceeds relatively predictably. These children seem to acquire object words more readily than action words and words beginning with sounds in their phonological repertoire versus not in their repertoire (Leonard et al, 1981; Schwartz and Leonard, 1982). Research examining the lexical acquisition of specific LI children found the same trend (Camarata and Schwartz, 1985; Leonard et al, 1982; Schwartz and Leonard, 1985). Knowing the normal course of lexical acquisition provides clinicians with guidelines for training lexical development in LI children.

Language learning strategies have been another focus of research concerning the language acquisition process. Imitation and comprehension are two strategies documented in the normal literature as being important for language production. Spontaneous, unsolicited imitations seem to herald the onset of spontaneous productions of lexical items and early grammatical structures for many normally developing children (Bloom et al, 1974; Folger and Chapman, 1978; Leonard et al, 1979; Scherer and Olswang, 1984). Intervention studies with LI children have been inconsistent in supporting this finding (Schwartz and Leonard, 1985; Olswang and Coggins, 1984). In general, spontaneous imitations appeared to facilitate lexical acquisition, although differences were noted (Schwartz and Leonard, 1985). Olswang and Coggins (1984) found less of a direct relationship between the emergence of spontaneous imitations and spon-

taneous productions of multi-word combinations. Comprehension abilities have also appeared to precede production of new forms in normally developing children (Benedict, 1979; Gleitman and Wanner, 1982; Whitehurst, 1982). The implications of this have been to train comprehension skills in an attempt to facilitate production. Schwartz and Leonard (1985) and Leonard et al (1982) found LI children learned lexical items without production practice, which supported the literature on normal acquisition that comprehension often precedes production. However, in a training study, Connell (1986) found comprehension training was not sufficient to teach six LI subjects to produce semantic relations meaningfully in their spontaneous language. Thus, the extent to which comprehension precedes production in LI children or the extent to which the pattern of comprehension and production deficits of specific children influence their responsiveness to specific modes of training has not been determined.

A common theme across the intervention studies has been variation in profile of deficit, and hence performance, of clients receiving treatment. Some techniques appear to work particularly well with some children and not with others, and some children seem to use a particular language learning strategy, while others do not. Learning a new language ability can be viewed on a continuum from emergence of that particular ability to mastery of the ability. Emergence to mastery of a new behavior proceeds at an uneven rate, often referred to as "growth spurts," and characteristically is accompanied by increased imitations, overextensions, and self-corrections in normally developing children. Evidence supporting the nonlinearity of language learning, as defined by readiness and growth spurts, has continued to accumulate in the literature examining LI children (Gibson and Ingram, 1983; Olswang and Coggins, 1984; Olswang et al, 1983, 1986). Such data suggest there may optimum times for direct treatment and times when benefits from treatment may be negligible. This may vary depending on the profile of language disorder and the age and stage of language development the child is at.

Research investigating the acquisition process has contributed important information during the last five years. The data have further supported the use of the normal developmental model for providing clinicians with guidelines for selecting treatment objectives and some teaching strategies. While this model has a very clear role in planning intervention for impaired children, it needs to be evaluated with other models to determine degree of effectiveness. Models focusing on functional communication or compensatory strategies may be more appropriate with some children and should be evaluated accordingly. Language intervention research has paid little attention to determining what is being taught during the treatment process. The answer is unknown as to whether clinicians are capable of teaching compensatory learning strategies (as tools for improving attending and discriminating) underlying concepts (as the spatial concepts underlying the use of prepositions), and/or linguistic rules (as which lexical verbs take objects). Further, how treatment interfaces with the maturation process is unclear. Little evidence is available for suggesting whether treatment induces the emergence of a new structure or only accelerates its mastery. The role treatment plays in altering the acquisition process of LI children must be defined. Research needs to investigate the learning process, to determine whether success is being achieved with children exhibiting different types of deficits, in the teaching of different learning

strategies, concepts, and/or structures. Further, research is needed to explore the timing of treatment to determine if there are optimum times for providing direct stimulation in relationship to such maturational phenomena as readiness and growth spurts. The implication is that there may be times when treatment will be more beneficial than others, and indeed, times when treatment is unwarranted.

## B. Processing Interventions

At the present time, a shift is occurring toward an increased understanding of the processing aspects of language acquisition. The new technologies available for analyzing and generating well-controlled acoustic stimuli may be one of the most significant forces behind this shift. The use of this technology has enabled researchers to identify the specific acoustic features of speech that contribute to perception (Kuhl, 1982). Auditory neurophysiologists (Kiang, 1980; Delgutte, 1980) are attempting to discover how the auditory nervous system processes these acoustic events and, ultimately, what processes are involved in the perception of speech and hence language. The current theories of speech perception include auditory as well as phonetic levels of processing. These interact with each other, as well as with motor functions and levels of linguistic functions. Some of the more recent attempts to formulate intervention programs for LI children, specifically those with comprehension deficits, reflect these current theories (DuBard, 1983; Lasky, 1983; Lasky and Cox, 1983; Butler, 1983, 1984; Sloan, 1980, 1985, 1986).

General intervention approaches are represented in the work of Butler (1981, 1984), Lasky and Cox (1983) and Matkin (1977). These approaches have been developed primarily for school-age children who exhibit language and learning disabilities that reflect basic processing disorders. In these approaches, auditory processing difficulties are seen as a component of the language and learning problems. The general goal of these approaches is to develop methods to use with these children that will facilitate learning in the classroom. Since classroom content is most often presented through oral and written language, these approaches focus on both auditory and linguistic components of processing.

Butler (1981, 1983) uses an information processing model to direct both assessment and intervention of language processing. She suggests that clinicians analyze remediation tasks in terms of stimulus characteristics, processing characteristics, and information load (Butler, 1981). Such aspects as attention, perceptual processing, memory, rehearsal strategies, search procedures, retrieval, processing load, temporal aspects of processing, facilitation of responses, and metalinguistic and metacognitive factors are considered (Butler, 1984). Butler advocates controlling these variables in assessment procedures to determine a child's ability to process verbal information and then manipulating these same variables in intervention to facilitate the child's information processing strategies.

Although Butler takes a general language processing approach, many of the intervention practices she recommends relate directly to the difficulties that children with auditory processing disorder (ADP) exhibit. For example, she states that the rate of presentation of stimuli and changes in rate are as im-



portant as the semantic content (Butler, 1981). Butler (1983) offers several suggestions for training what might be called "compensatory strategies" so that a child can learn to overcome his/her short-term memory and language processing deficits. These include: 1) rehearsal training or deliberate memorizing of critical information; 2) conscious auditory monitoring or vigilance activities for specific lengths of time; 3) permitting the child to control the response rate to speeded tasks; 4) teaching the child self-testing and self-monitoring procedures; 5) teaching subskills or components of tasks before requiring performance of a larger task; 6) teaching mnemonic devices such as chunking, clustering, rhyming, and categorizing; and 7) providing instruction in recall strategies such as active rehearsal or reauditorization.

Lasky and Cox (1983) also take a broad approach to language processing disorders. Their approach considers aspects of the signal and its presentation, the environment, the response required from the child, and the strategies the child uses as factors that affect auditory processing. Intervention practices are recommended that manipulate these factors so as to facilitate listening and learning. Lasky and Cox suggest including in intervention approaches signal manipulations (such as increasing intensity), linguistic strategies (such as using contextual cues), and strategic modifications (repetitions, rehearsing, and preteaching). Manipulations of the presentation rate include the rate of speaking and the rate at which new information is presented. Intervention must indicate finding a level at which the child can listen and learn well, then gradually increasing the complexity of the signal and rate of presentation. The environment is enhanced by improving the signal-to-noise ratio in the beginning, then gradually introducing competing signals in the environment.

Matkin has developed a list of guidelines for classroom management of children with auditory processing disorders. These guidelines consider such things as classroom placement and seating arrangement that minimize noise and reverberation and allow children with APD to be able to see and hear the teacher. Matkin suggests that teachers modify their behavior to enable children with APD to attend and comprehend verbal instructions. Many of these suggestions are similar to those of Butler (1981, 1983) and Lasky and Cox (1983), for example: rephrasing and restating, using brief instructions, preteaching, listing key vocabulary, and using visual aids.

In summary, these general approaches focus primarily on how a child with language processing disorders can be managed in a learning environment. The emphasis is on facilitating comprehension and appropriate responding. These approaches can be viewed as ways to help the child compensate for the difficulties in auditory processing. Unfortunately, empirical support for the effectiveness of the approaches is not provided.

There are few specific and systematic intervention programs for children with processing disorders. Those that are available can be viewed as approaches directed specifically toward improving auditory processing and speech and language perception. They are based on models of speech perception which hold that if one's auditory processing mechanism cannot extract the necessary information from the acoustic signal, inaccurate perception of speech occurs. That which is misperceived is likely to be misunderstood. Therefore, accurate

and efficient auditory processing and the resultant accurate perception of speech is prerequisite to language learning. While these approaches acknowledge that higher levels of language interact with and influence auditory processing, they suggest that these higher levels, especially the phonological processes, are likely to be impaired as well because of insufficient or inaccurate input to them in the developing child.

One such specific approach is reported by DuBard (1983) and is a continuation of the Association Method developed by McGinnis. This method is highly structured and systematically organized so that instruction consists of teaching incremental units of language and speech beginning with phonemes and then gradually including larger and more complex units of communication. The method has been criticized as being contrary to normal language learning. However, DuBard (1983) points out that the normal child has countless experiences with smaller units of language in the early prelinguistic stage of development--uttering them, storing them, retrieving them, and making proper associations. The LI child, on the other hand, does not have such experiences, does not develop these processes to the same extent, and exhibits multiple uncertainties about the units of language and speech. The Association Method is designed to give the LI child these kinds of experiences.

Although McGinnis developed the Association Method for school-age children, emphasizing both oral and written language, DuBard (1983) stresses the auditory training aspect of the method for younger children who are not capable of the necessary articulation or copying skills required in the association technique. She hypothesizes that it is the auditory processing problem, that is, the processes of identifying, discriminating, and using auditory stimuli, that is the major difficulty in LI children. This is supported by considerable research with LI children (Tallal et al, 1985, 1986).

A more recently developed program of intervention for APD has been published by Sloan (1986). This program is specifically designed to improve auditory processing so that accurate perception of speech can occur. It focuses on training children to discriminate the distinctive features of speech sounds that are at the basis of the phonologic system. Modifications to the signal and its presentation (auditory cues) are used by the clinician in the beginning to enable the child to distinguish between a minimally distinct pair of speech sounds embedded in a CV unit. As the child progresses in the program, these modifications are faded until accurate identification of each sound in the pair is achieved. Subsequently, the contrast sound pairs are presented in systematically more varied and complex phonetic contexts until accurate identification is achieved in multisyllabic words. Sloan's approach involves intensive auditory training, but, at the same time, provides accurate and repetitive input to the phonologic system. Sloan (1980) reported the effectiveness of this method in training a five-year-old LI child. This child initially required many trials and treatment sessions to be able to distinguish minimal phonetic pairs, such as [t] from [d]. However, once distinctions were acquired, the child was able to generalize training to distinguish features in other consonant contrasts almost immediately.

Other specific treatment approaches that have been published include those of Katz (1983), Katz and Harmon (1981), Tomatis (1978), Musiek (1986) and Lin-

damood (1980). Musiek (1986) reports that there is some clinical observation of improvements in auditory processing achieved when children use personal FM units in the classroom. These are limited output units of the Walkman type that are comfortable to wear, reasonably priced, and have a 30 to 40 dB gain. They are used primarily to improve the signal-to-noise ratio in the classroom setting, but could be used as high fidelity training systems to amplify those specific acoustic features of the speech signal. Shapiro and Mistal (1985) reported on four children with eading, spelling, and auditory processing problems who benefitted from high-frequency-enhanced, in-the-ear hearing aids. Musiek reports that while the use of low gain amplification systems looks promising, no empirical data are yet available on their use for APD.

The Auditory Discrimination in Depth (ADD) program developed by Lindamood (1980) is an oral-motor approach to beginning reading instruction. This program was developed to train kindergarten and first grade children in segmentation and blending skills associating awareness of oral-proprioceptive qualities of phoneme production to auditory and visual properties of speech. In a recently completed doctoral dissertation, Howard (1986) reports the results of controlled research extending over 11 years examining ADD program effects on first grade entry and exit reading scores as measured by the Woodcock Reading Mastery Tests and the Reading Subtest from the Iowa Tests of Basic Skills. Analyses of co-variance with the pretest as the co-variate indicated that first grade students trained in the ADD techniques made greater gains in word attack and reading achievement in first grade and had higher reading scores in subsequent grades (second through eighth) than students not receiving such training; kindergarten children trained in ADD techniques entered first grade with higher word attack skills than students not receiving such training. Lindamood has concluded, based on these impressive research results, that training specific auditory and visual properties of speech perception and production in young children has a significant effect on their subsequent reading and spelling abilities throughout the elementary school years.

The outlook for intervention for auditory processing disorders is quite promising in light of the renewed interest in this specific aspect of language disorders, based on current research with LI children. In order to continue to make advances, however, continued research is needed on: 1) the development of auditory processing, psychoacoustic abilities, and speech perception in normal children; 2) the development of auditory and language functions in LI children; 3) the effectiveness of auditory versus non-auditory based intervention programs; 4) the development of solid diagnostic methods within the disciplines of audiology and speech-language pathology for the identification of APD particularly at a young age; and 5) long-term follow up of LI children for the purpose of investigating whether deficits in auditory processing persist, or are resolved through maturation and/or treatment, and how these deficits relate to reading, writing, and other learning disabilities.

#### C. Assumptions Pertaining to Treatment

Documented principles of intervention need to be available for speech/language pathologists to be able to make informed decisions regarding the management of

LI children, particularly: who should receive intervention, what behaviors should be treated, how intervention should be conducted, when treatment should be implemented and for how long. Being accountable in service delivery requires that speech/language pathologists make such decisions confidently and validly. Unfortunately, intervention research has provided speech/language pathologists with a limited number of principles on which to rely in making these critical management decisions. Rather than base their decisions on empirically determined principles of intervention, clinicians are forced to decide who and what to treat, how to treat, when and for how long, based upon their assumptions regarding language acquisition and the role of intervention.

In reviewing intervention research and observing clinical decision making, the following list of assumptions appear to guide speech/language pathologists in their work:

1. Direct treatment is required for "any child abnormally slow in one or more aspects of language development or has certain biological or behavioral characteristics that place him/her at risk for such a delay in development." (Fey, 1986)
2. The earlier treatment can be provided, the better the outcome (Marge, 1972; Menyuk, 1975) and the more people involved in intervention, the better (McCormick and Goldman, 1984).
3. "Language intervention . . . can facilitate the child's growth of linguistic abilities and may even help him/her catch up to peers." (Fey, 1986)
4. Language intervention will facilitate an impaired child's ultimate linguistic achievement, and without such intervention, the child's potential may not be realized (Leonard, 1983; Fey, 1986).
5. Language intervention stimulates overall language development. When this occurs, an individual may be said to have learned a strategy or means of acquiring language, and is able to acquire new forms and functions without receiving systematic instruction on them (Guess et al, 1973; Warren and Kaiser, 1986).

Unfortunately, such assumptions are based on intuition rather than empirical data, as intervention research, thus far, has focused on other issues (treatment effectiveness, effects, and the acquisition process) and, in fact, these assumptions have not been subjected to research query. While most research has not been designed to directly address who and what to treat, how to treat, when to treat, and for how long, the outcome data do tangentially speak to these questions and suggest some underlying principles for making these clinical decisions.

Research reviewed previously has contributed to the knowledge base guiding two important language intervention decisions: what behaviors to teach and how. However, research support for principles addressing who to treat, when to treat, and how long to treat is quite limited. Clinicians tend to rely on their assumptions and intuition when it comes to making these clinical



decisions. "Who to treat" refers to service delivery decisions and, more often than we wish to acknowledge, public resources available to fund treatment. Deciding whether a child will benefit most from direct treatment planned by the speech/language pathologist, but implemented by a parent or classroom teaching, or from no treatment at all, should be a decision based on empirical data. Speech/language pathologists have few guidelines regarding which children can benefit from treatment, and if in treatment, which service delivery option would be best. The normal developmental model has been used almost exclusively for determining which children should be enrolled for treatment (Fey, 1986). While this has been useful, the assumptions on which this decision has been based have not been documented. The identification of a language delay using a normal, developmental model speaks only to the extent of a child's handicapping condition; it does not address potential for change under different types of service delivery options. Research identifying principles to guide the decision of "who to treat" is clearly needed. Uniformity across districts and states, to insure equity in services based on need (rather than resources) is a critically pressing issue in need of review.

A related question is "when to treat," suggesting there may be an optimum time for direct treatment. Data have indicated the timing of direct treatment may account for maximum effectiveness and efficiency of behavior change. The lack of robust results in group designs that have compared treatment may reflect the timing variable. Direct treatment in general, or even specific, procedures may be the most effective in changing behavior at different times during the language acquisition process from the emergence to mastery of new behavior. If this is the case, research must continue to examine the learning process, and determine when children are most likely to benefit from intervention.

Theoretical evidence supporting this line of research comes from the works of Vygotsky (1978) and Gottlieb (1976) suggesting rate of learning may vary depending upon where a child is in the learning process and the influence of "experience" on learning at different points in time. Vygotsky's "zone of proximal development" defines the distance between a child's actual level of functioning and his/her potential level of performance. The "zone" defines a child's potential for immediate change when contextual support is manipulated to enhance performance; this, in turn, reveals a child's ability to learn. Children whose performance can be enhanced by the manipulation of contextual cues are ones who may benefit most from direct clinical intervention.

Gottlieb (1976) has suggested that rate of change is indicative of how "experience," in this case, treatment, serves to "regulate maturation, hasten development, and improve performance." Experience can change behavior in different ways depending upon what the behavior is, and where the person is in the learning process. The theory behind the works of Vygotsky and Gottlieb argues for critical learning periods, that is, optimal learning times when change in an organizational process is easily altered, modified, or produced. Indeed, research has supported the concept of readiness and critical learning periods with respect to intervention (Olswang et al, 1983, 1986; Olswang and Collins, 1984). These studies have provided preliminary evidence that children will perform differently in treatment depending upon where they are in the learning process. Some behaviors require intensive direct treatment to stimulate change, whereas others require little or no direct treatment. Clinicians

need to be responsible and accountable in providing only necessary treatment and in a time frame that is most advantageous to the client. Research is needed to identify critical learning periods for linguistic behaviors, and to determine children's behaviors indicating learning readiness. Further studies must explore changing behavior (i.e., progress) under different service delivery options (i.e., no treatment, direct treatment, and indirect treatment).

Once a child has been enrolled in treatment, the speech/language pathologist must determine "how long" to provide services. This decision encompasses two aspects of the learning process: 1) how much direct treatment is necessary before automatic transfer of learning occurs; and 2) what is the ultimate outcome of intervention for a particular child and behavior.

The first issue addresses the concept of "instrumental outcomes," those outcomes which "lead necessarily to other outcomes without further intervention (Rosen and Proctor, 1981). An ultimate outcome of intervention is "communicative competence," but whether direct treatment is needed continuously until that is achieved is unknown. Treatment may need to be provided only until an instrumental outcome is achieved, that is, an earlier emerging behavior or performance may herald the mastery of the ultimate desired behavior change. The research findings suggesting that generalization of new behaviors may not need to be taught to LI children under particular circumstances, supports this notion. Assuming children need to be treated until "mastery" is achieved appears to be erroneous, and indeed is a costly assumption. Research is needed to define instrumental outcomes, which may vary across children. Furthermore, there is a need to define the methodology for identifying these outcomes in individual children. The latter may be the more feasible undertaking.

Finally, further research is needed to investigate ultimate outcomes. These are performance outcomes indicating treatment has been a success and intervention can be terminated completely (Rosen and Proctor, 1981). Deciding how long to keep a child on the therapeutic caseload is difficult, for it forces a clinician to decide if his/her services can be of any further value to the impaired child or family. The main issue is what to define as the ultimate goal of treatment; behaviorally, what is expected from the client? Should "normal" performance be the ultimate achievement? What defines normalcy? Does the definition vary across children? And, finally, how does one measure the ultimate outcome? Expectations regarding language competence must be defined and weighed against different child characteristics. The ultimate goal of intervention must be a socially valid outcome, and yet what this means in terms of the LI child is not known. Longitudinal research is needed to determine which LI children will eventually perform like their normally developing peers and which will not. Both the short and long-term effectiveness of intervention needs to be evaluated.

The state of the art regarding language intervention reflects a great need for research to uncover principles by which speech/language pathologists can make better clinical decisions. While we know language behaviors can be successfully altered, so much about the intervention process remains unknown. The role of the interventionist can only be defined when theoretical issues regarding the nature of language, language disorders, and language change are

better understood. This will require research investigating the assumptions under which clinicians currently operate. While the practicing clinician can continue to document the efficacy of treatment procedures, systematic, programmatic research is needed to address the major intervention assumptions and to generate principles for making informed clinical decisions regarding who and what to treat, how best to treat, when, and for how long.

## VI. Prognosis

Issues of prognosis of language impairment are important to every other aspect of this report. Indeed, until we know what the long-term effects or outcomes of a disorder are, it is impossible to determine the extent of the problem, and hence, the need for research and treatment. Particularly with language disorders, it is important to know if children are merely delayed in the onset of function, or if they will demonstrate long-term deficits as a result of early disability. Considering the importance of issues pertaining to prognosis, it is amazing how little empirical information there is on this topic. The few longitudinal studies evaluating outcomes (prognosis) of language disorders that have been published (Stominger and Bashir, 1977; Hall and Tomlin, 1978; Aram and Nation, 1975, 1980; Griffiths, 1969; Silva et al, 1983; King et al, 1982) suffer from two serious methodological flaws: 1) they have been retrospective studies; and 2) they have included children who are highly variable in terms of their physical and intellectual status, and hence, are not specifically language impaired. Thus, the outcomes reported cannot be related to language disorders, per se. (See Aram et al, 1984, for a review of this literature.)

The NINCDS-funded San Diego Longitudinal Study of the Outcomes of Early Language Impairments in Children (Tallal and Curtiss, 1980-1988) has been designed specifically to address critical issues pertaining to patterns, profiles, and/or subtypes of specific early language disorders and the extent to which these subtypes maintain themselves throughout development and are meaningful predictors of subsequent outcomes (prognosis). Many issues critical for both theoretical and clinical understanding of the outcomes of specific developmental language disorders are being addressed in this landmark study. Until these outcomes are understood, appropriate services cannot be provided for these disabled children.

One important question pertaining to outcomes of specifically language disordered children is the degree to which members of subgroups of LI children maintain their subgroup membership over time and whether group membership is related to prognosis. Tallal and Curtiss are administering a set of standardized language measures to each child in their longitudinal study at the end of each year. They can thereby assess whether each child falls into the same subgroup each year of the study as he/she did at intake. Preliminary analyses have yielded an unexpected and important finding. Children who show primarily expressive language deficits at age four appear to show the most rapid and significant progress from that point on. By the second year of the study, more children in this subgroup tested in the normal range on standardized tests than children in any other subgroup studied. This tendency for children with primarily expressive deficits to improve dramatically on their test performance after the first year of the study is proving consistent in the later

years of the study, as well. Although the results of detailed linguistic analyses of the same children suggest that the classical subgroupings may not be relevant regarding what a child may know or have difficulty with linguistically, and therefore not relevant with respect to language intervention, they may be exceptionally important prognostically, with children demonstrating receptive language deficits being considerably more at risk for long-term disorders than those with primarily expressive deficits. Similarly, results from this same longitudinal study demonstrate that, unfortunately, the prognosis for a majority of LI children must include subsequent academic failure, especially in areas, such as reading and spelling, that rely on the same auditory perceptual and phonological building blocks as oral language.

Distressingly, to date, the long-term prognosis for children with early language disorders has yet to be adequately evaluated. Longitudinal studies following LI children throughout the school years, and potentially into adulthood, must be undertaken to determine the true magnitude of this complex cognitive developmental disorder. These studies must be multidisciplinary in nature, evaluating etiological, neuropsychological, linguistic, academic, social, and emotional factors in the same child over time. Multi-site studies would also be an innovative approach to allow for larger samples of well-selected cohorts to be uniformly studied, and results to be cross-validated.

## VII. Future Research Goals

Until recently, priority has been given to funding small, isolated, single variable studies. Few of these studies have pursued a consistent, theoretically driven model or line of research. Not surprisingly, results have been fragmented and have led to disappointingly little integration across studies and, hence, advancement of our knowledge of specific developmental language disorders. The NINCDS, NICHD, and NIMH must be commended for recognizing that the pressing clinical and theoretical issues pertaining to complex developmental cognitive disorders must ultimately be addressed by funding complex (multidisciplinary), developmental (longitudinal) studies. Future studies would benefit most from being both practically and theoretically driven. That is, if specific developmental language disorders are ever to be prevented, we must first begin by understanding their etiology (causes) and prevalence in the population and then develop appropriate treatments. This can never be accomplished if uniformly applied inclusionary and exclusionary criteria for diagnosis are not established and their use enforced. This will rely ultimately on the development and uniform use of well-standardized, reliable, and valid testing procedures.

Finally, future theoretical and technological advances will create increasing demands for more sophisticated, multivariate research designs, data-based management systems, and innovative statistical analysis procedures. The complexity of language development as it relates to all other aspects of child development, by its very nature, must lead to more reliance on increasingly complex, multivariate research designs. In order for the number of variables to be appropriately assessed by these multidisciplinary, multivariate designs, it may be increasingly necessary to move to a more collaborative (less competitive) research arena in the future, where researchers are encouraged to



work together across disciplines and sites to develop the large subject populations needed for such research to be successful. The NICHD, NINCDS, NIMH, and MacArthur Foundation are to be highly commended for their leadership into the future, demonstrated by the recent advances they have made in breaking down competition and sponsoring (through significant research funding) several large-scale collaborative, multidisciplinary, multi-site programs in the area of child development. These first few attempts at cooperation between and across disciplines and geographical locations are already demonstrating exciting and promising breakthroughs.

Developmental language disorders are, fortunately, not life-threatening. However, they may well be life-destroying in many cases. For all of our goals for these children ultimately to be reached, we must do everything we can to break down artificial professional and scientific boundaries and to promote collaboration and cooperation in the future.

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